New York City Department of Environmental Protection
Bureau of Water Supply

Waterfowl Management Program

July 31, 2012

Prepared in accordance with the Final 2007 (Waterfowl Management Program-Section 4.1) of the United States Environmental Protection Filtration Avoidance Determination

A Waterfowl Management Program was developed to evaluate and mitigate pollutant impacts (fecal coliform bacteria) from migratory and resident waterbirds (waterfowl, gulls and cormorants). The purpose of the study reported here, for the period April 1, 2011 to March 31, 2012, is to evaluate further the trends observed in bird numbers and their effect on fecal coliform bacteria levels as a consequence of DEP's Waterfowl Management Program.

Prepared by: Christopher A. Nadareski, Section Chief, Wildlife Studies
NYC Department of Environmental Protection
Bureau of Water Supply
Division of Watershed Water Quality Operations

TABLE OF CONTENTS

LIST OF FIGURES **Page Number**

LIST OF FIGURES (continued) **Page Number**

LIST OF FIGURES (continued) **Page Number**

LIST OF FIGURES (continued) **Page Number**

List of Tables **Page Number**

ACKNOWLEDGMENTS
Special thanks to DEP wildlife biologist Mike Reid, Wildlife Studies who reviewed this document, assisted with data collection, contract management, and production of the maps for this report and Matthew Sudol, Wildlife Studies for field observations and also provided a review.

Thanks goes to the DEP contractor, HDR – Henningson, Durham, and Richardson P.C., including James Morrison, Vice President, William Saksen, Laboratory Director, Don Henshaw, Asst. Laboratory Director, Katherine Drury, Field/Lab Coordinator, Ben Wood, Field Site Supervisor, Paul Oehrlein, Ornithologist, Kenneth Eggleson, Ornithologist, Matthew Sudol, (former) Ornithologist Technician, Sean Camillieri, Ornithologist Technician, Marc Hecht, Ornithologist Technician, and numerous other contractor staff for implementing the Waterfowl Management Program Contract.

Thanks to Lori Emery, Chief of Watershed Water Quality Operations (WWQO) for a critical review of the document and logistical support and Steven Schindler, Director of BWS Water Quality for document review. Additional thanks to Andrew P. Bader, Deputy Chief, WWQO, Charles Cutietta-Olson, Deputy Chief, WWQO, Salome Freud (Chief), Virginia Murray (Deputy Chief), Aspa Capetanakis, and staff from WWQO field and laboratory for providing water quality data for Kensico, West Branch, Rondout, Ashokan, Croton Falls, and Cross River Reservoirs and Distribution Water Quality Operations (DWQO) for providing Hillview Reservoir water quality data. Finally, thanks to the Operations Directorate (James Porter, PhD and Glenn Horton) for meteorological data.

DEP would also like to acknowledge the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA), NYS Director, Martin Lowney and staff for consultation assistance and implementation of the Hillview Duck Management Contract. Finally, DEP acknowledges the New York State Department of Environmental Conservation staff from the Region III Office in New Paltz, New York for consultation and assistance with nuisance wildlife issues and banding of locally breeding Canada Geese.

The author, Mr. Christopher A. Nadareski, is DEP's Section Chief of Wildlife Studies and is responsible for the Waterfowl Management Program oversight including data management, field data collection, and contract administration.

INTRODUCTION

The management of waterbird populations at key reservoirs throughout the New York City Water Supply is essential to meet stringent water quality regulations as stated in the Environmental Protection Agency's (EPA) Surface Water Treatment Rule (SWTR) of 1991 (EPA 1989). As a result, DEP developed and implemented a comprehensive Watershed Protection-Filtration Avoidance Program to protect its water supply. A component of the Watershed Protection Plan is DEP's Waterfowl Management Program (WMP) which was established to research the relationship between wildlife, particularly waterbirds (geese, gulls, cormorants, swans, ducks, and other duck-like birds) that inhabit the reservoirs, and fecal coliform bacteria elevations in the untreated surface water. The Waterfowl Management Program, originally developed for NYC's Kensico Reservoir in 1992, has been expanded to include five additional reservoirs for waterbird management under the November 2002 Filtration Avoidance Determination (FAD) (Section 4.1 – Waterfowl Management Program). The most recent FAD update (2007 FAD) includes bird management at Hillview Reservoir in Yonkers, New York. The new FAD (proposed 2012) is expected to be approved and released during the summer of 2012.

The WMP was designed to study the relationship between seasonal trends in bird populations on the reservoirs as well as trends in fecal coliform concentrations both within the reservoir and at the keypoint water sampling locations. 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 the Kensico Reservoir (DEP 1993 - 2011). In response, DEP developed and implemented a Waterfowl Management Program using standard bird management techniques (approved by the United States Department of Agriculture, Animal and Plant Health Inspection Service, 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 2002). DEP has also acquired depredation permits from the United States Fish & Wildlife Service (USFWS) and DEC to implement some management techniques. Since the initial implementation of DEP's bird dispersal and deterrent techniques in 1993 there has been a dramatic reduction in both bird populations and fecal coliform levels, thus maintaining high quality water in compliance with the SWTR.

Migratory populations of waterbirds utilize NYC reservoirs as temporary staging areas and wintering grounds and therefore can significantly contribute to increases in fecal coliform loadings in the reservoirs during the autumn and winter primarily from direct fecal deposition. 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 high per gram of feces (Alderisio

and DeLuca 1999). Water samples collected near waterbird roosting locations have shown fecal coliform increases concurrent with waterbird populations at several NYC reservoirs in previous DEP reports (DEP 1993 - 2011). 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, and Ashokan) and potential source reservoirs to the Catskill-Delaware System (Croton Falls and Cross River). Since waterbirds have been associated with elevated fecal coliform bacteria levels found in various reservoirs and lakes (DEP 1994 and 1995), a program to discourage waterbird activity was developed for Kensico Reservoir in the autumn of 1993 and is expected to continue indefinitely. The bird dispersal program was more recently expanded to Rondout Reservoir during the winters of 2002/2003, 2003/2004 and 2005/2006, West Branch Reservoir in 2007 and 2010/2011 and at Croton Falls Reservoir during the winter of 2001/2002 on an "as needed" basis. To assure DEP's program activities remained in compliance with all federal, state, and local laws including effects on local environmental conditions including endangered species an Environmental Impact Statement was completed for Kensico in 1996 and another one in the spring of 2004 for five additional reservoirs (Rondout, West Branch, Ashokan, Croton Falls, and Cross River). A Final Environmental Impact Statement including a "findings statement" can be found on the DEP website identifying program impacts and required mitigation to meeting implementation standards for the expanded WMP. This report is a requirement of the 2007 FAD.

The purpose of this report is to evaluate further the down-trend observed in waterbird populations and its impact on fecal coliform bacteria concentrations as a consequence of DEP's Waterfowl Management Program for the period April 1, 2011 through March 31, 2012.

METHODS

Under the DEP's Final 2007 Filtration Avoidance Determination Section (FAD), Waterfowl Management Program Section 4.1, it specifically states the following:

4.1 Waterfowl Management Program

The Waterfowl Management Program was initiated in 1993 by the City for the Kensico Reservoir in response to elevated coliform bacteria levels contained in the Reservoir. The 2002 FAD required that the City continue this program for the Kensico Reservoir on a routine basis and expand the program on an "as needed" basis for five additional reservoirs. Three of these five reservoirs (West Branch, Rondout, and Ashokan) routinely serve Kensico with its source water. The remaining two (Cross River and Croton Falls), while in the Croton system, may serve Kensico with source water under special circumstances. The objective of the program is to minimize the fecal coliform loading to the reservoirs that result from roosting birds during the migratory season. The program includes three activities: avian population monitoring, avian harassment activities (motorboats, airboats, cannons, physical chasing, and pyrotechnics) and avian deterrence (depredation of nests and eggs, bird exclusion wires, and netting at critical intake chambers). All avian harassment techniques and deterrence activities have been approved by USDA and DEC.

The City's 2006 Long-Term Watershed Protection Program expanded the Waterfowl Management Program on an "as needed" basis to include avian harassment activities for the Hillview Reservoir as well as avian deterrent measures for Hillview and other City reservoirs. The term "as needed" refers to implementation of avian management measures based on the following criteria:

- Current bird populations, including roosting or staging locations relative to water intakes;
- Fecal coliform bacteria concentrations approaching or exceeding 20 fecal coliform per $100mL^{-1}$ water samples collected at reservoir effluent structures coincident with elevated bird populations;
- Recent weather events;
- Operational flow conditions within the reservoir (i.e. elevations and flow patterns and amounts);
- Reservoir ice coverage and watershed snow cover; and
- Determination that active bird management measures would be effective in reducing bird populations and fecal coliform bacteria levels.

The 2007 FAD (Table 1) requires that DEP continue implementation of its Waterfowl Management Program in accordance with Section 2.3.1 of the City's 2006 Long-Term Watershed Protection Program and the milestones therein with the following clarification:

- DEP will perform avian population monitoring in accordance with the frequencies specified in the City's 2001 Watershed Protection Program Summary, Assessment and Long-term Plan.

Table 1. Final 2007 FAD requirements.

Requirement	Due Date
Active Bird Harassment – Kensico Reservoir	8/1 to 3/31; Annually
"As needed" Bird Harassment – West Branch, Rondout, Ashokan, Cross River, Croton Falls, and Hillview Reservoirs	8/1 to 4/15; Annually
Avian Deterrent Measures – Kensico, West Branch, Rondout, Ashokan, Cross River, Croton Falls, Hillview Reservoirs and other City reservoirs as needed	Year-round; Annually
Submit annual summary of Waterfowl Management Program activities including contract status, and implementation and analysis of all program elements (including special studies)	7/31; Annually

Waterbird Census

The relationship between elevated waterbird counts and increased levels of fecal coliform bacteria identified from raw water samples is well established. New York City reservoirs, situated in southeastern New York State, lie in the Atlantic Flyway, an important migratory pathway for many groups of birds including waterbirds. The NYC reservoirs offer important areas of open water used for night roosting, foraging, winter stop-overs, and breeding habitat for some waterbirds species. Since it has been well documented that the primary bacterial contribution of the water supply is from night-roosting and migratory birds, night census data is presented throughout this report. Defecation rates of birds are known to be somewhat lower nocturnally than diurnally.

Daily waterbird observations were conducted at predawn hours (between 4:30am and 8:00am E.S.T.) and post dusk hours (between 5:00pm to 10:00pm E.S.T.) to determine overnight waterbird roosting populations and to evaluate the success of the hazing activities from the previous day (where applicable) at all reservoirs. Survey times vary seasonally reflecting available daylight hours. Since it has been determined that most birds roost nocturnally, and generally fly off the reservoir during extended periods of the day, all population monitoring data reflect overnight roosting (DEP 1993). For successful data collection, ideal weather and atmospheric conditions were necessary. Otherwise precipitation events and fog prohibited data collection resulted in short gaps of "no data". Reservoir maps with bird zones can be found in Appendix A.

The July 2007 FAD, Section 4.1 specifies the frequency of reservoir surveys and is listed in Table 2. Proposed and actual surveys conducted from April 1, 2011 to March 31, 2012 are also listed in Table 2.

Table 2. Frequency of bird observation surveys by reservoir 2011/2012 (as listed under the November 2002 FAD, Section 6.4.1 and EPA Administrative Order on Consent governing the covering of Hillview Reservoir (Docket No. SDWA-02-2010-8027 Catskill Delaware System).

Reservoir	Bird Surveys Scheduled	Proposed/Actual Surveys
Kensico	Pre-dawn to Post-dusk Daily August 1 to March 31; Pre-dawn and Post-dusk Weekly April 1 to July 31	260/256[1]
West Branch	Pre-dawn, Midday, and Post-dusk Weekly all year; Increased to daily "as needed"	52/52
Rondout	Pre-dawn, Midday, and Post-dusk Weekly all year; Increased to daily "as needed"	52/52
Ashokan	Pre-dawn, Midday, and Post-dusk Weekly all year; Increased to daily "as needed"	52/53
Croton Falls	Pre-dawn, Midday, and Post-dusk Bi-weekly all year; Increased to daily "as needed"	26/26
Cross River	Pre-dawn, Midday, and Post-dusk Bi-weekly all year; Increased to daily "as needed"	26/27
Hillview	Pre-dawn, Midday, and Post-dusk Weekly all year; Increased to daily "as needed"	366/364[2] (night) 366/364[2] (day)

[1]A total of three surveys were cancelled due to holidays and two additional surveys were cancelled due to inclement weather (Tropical Storm Irene).
[2]Two surveys were cancelled due to inclement weather (Tropical Storm Irene)

Reservoir-wide observational surveys for waterbirds were conducted year-round at all six reservoirs listed (Table 2). Each survey records species evenness (number per species), species richness (species diversity), roosting and foraging locations, band/collar identifications, and general behavior during the overnight roosting period. Waterbird data is collected from shoreline locations and/or watercraft (motorboat, airboat, or canoe) by a wildlife biologist, ornithologist, or wildlife technician using binoculars and spotting scopes. DEP developed field data sheets to record observation locations with times for each reservoir. Data is entered in an Excel spreadsheet and is checked twice for Quality Assurance/Quality Control. Each survey data point can consist of a minimum of one or two site visits per datum reported (i.e. night before and morning after the nightly roost), and is dependent on the field conditions (i.e. weather, fog), reservoir physical characteristics (i.e. drought), and time of year (leaf-cover or not). Data

collected during reservoir-wide surveys that were incomplete due to inclement weather were not recorded. Only high counts for each category of waterbirds are used for data recording. For example, if there was a count of 20 Canada Geese at a bird observation location and zero for the rest of the reservoir for the night before count and a count of 20 ducks at another location on the morning after survey, a combination of 20 geese and 20 ducks would give a reservoir-wide total of 40 birds. The purpose of using two surveys for data collection is ascertaining species highest concentrations over a specific time period. Some species at certain times of the year are easier to count at night when birds are flying into roost areas (or open water) in the evening whereas others are easier to count when flying out of the reservoir in the early morning.

Waterbird population zones were delineated at all reservoirs to identify local impacts on water quality and have been described in previous DEP reports for Kensico and West Branch (DEP 1994, 1995, 1997a).

Data reported on fecal coliform bacteria concentrations for both keypoint raw water outflow samples (aqueduct and outflows) and reservoir samples have been reviewed by DEP laboratory personnel. The following conditions apply to the water quality data reported:

- Only high concentration duplicate samples are reported (for example if two keypoint samples were collected in a single day, or if more than one sample is collected at different depths at a single limnology sampling location, the highest bacteria count has been used for charting)
- All special investigation samples are reported
- Reanalysis samples are reported
- There were no samples with confluent growth reported

Fecal Coliform Bacteria Data

Water quality data presented in this report were collected by DEP's Watershed Water Quality Operations personnel and analyzed and reported by four DEP New York State Department of Health (DOH) Environmental Laboratory Approval Program certified Laboratories in Valhalla, Kingston, Grahamsville, and Queens, New York. Watershed DEP Laboratory personnel utilize the Membrane Filtration Technique for fecal coliform analyses. Distribution DEP Laboratory personnel utilize the Colilert18 with Quantitray for *E.coli* analysis for samples collected at Hillview Reservoir. Reservoir-wide waterbird survey results are presented with fecal coliform bacteria levels at keypoint (outflow) and reservoir sampling areas.

Waterbird Dispersal Techniques

The list of bird dispersal activities conducted since 2002 is listed in Table 3. Waterbird dispersal techniques were employed at Kensico Reservoir from August 1, 2011 through March 31, 2012 using motorboats, Husky Airboats, noisemakers (pyrotechnics), and bird distress tapes. Pyrotechnics and propane cannons were used on a daily basis year-around at Hillview Reservoir during this reporting period. Dispersal techniques were conducted under two DEP Waterfowl

Management Program contracts (WMP-08 from April 1 to September 17, 2011 and WMP-12 from September 18, 2011 to March 31, 2012) by HDR (Henningson, Durham, and Richardson, P.C. of Pearl River, New York). The Kensico program will remain a permanent-based program conducted between August 1 and March 31 annually and Hillview will remain a daily, year-around program. Beginning daily at 8:00am and continuing until approximately 1.5 hours past sunset, bird hazing activities were conducted reservoir-wide, targeting all species except those with a federal or NYS endangered or threatened status (e.g. N.Y.S. Threatened Pied-billed Grebe (*Podilymbus podiceps*)). The Husky Airboats were available for bird harassment in 2011/2012 at Kensico. Airboats have the ability to ride over ice and water interfaces with ease. The airboats also have heated cabins which provide longer time periods of bird hazing opportunities (physical chasing and pyrotechnic use) during reservoir freezing periods throughout the winter. A contract was initiated with USDA to conduct lethal management of the resident duck population at Hillview Reservoir. Details of the contract work will be discussed in the Hillview Reservoir section of this report.

The other five reservoirs included in this report are covered under the "as needed" section for the expanded reservoirs. Detailed descriptions are listed below by reservoir.

Table 3. Reservoir bird mitigation (1993 – 2012).

Reservoir	Dates of Bird Harassment/Deterrence	Bird Harassment/Deterrence Measures Used
Kensico	August 1 – March 31 1993 to 2012	Bird harassment (motorboats, Husky airboats, pyrotechnics, and Bird distress tapes), waterbird reproductive depredation, shoreline meadow management and fencing, Alewife collections, and bird netting for terrestrial bird management (swallows, starlings, pigeons, etc.)
West Branch*	January 11 to March 28, 2007 December 15, 2010 to January 6, 2011 None required during this reporting period	Bird harassment (motorboats and pyrotechnics), waterbird reproductive depredation, and bird netting for terrestrial bird management (swallows, starlings, pigeons, etc.)
Rondout*	December 2002 – January 2003 December 2003 – January 2004 December 2005 – March 2006 None required during this reporting period	Bird harassment (pyrotechnics, red-beam lasers, and bird distress tapes) and waterbird reproductive depredation
Ashokan*	None required during this reporting period	Waterbird reproductive depredation

Croton Falls*	January – February 2002 None required during this reporting period	Bird harassment (motorboats, pyrotechnics, red-beam lasers, and bird distress tapes) and waterbird reproductive depredation
Cross River*	None required during this reporting period	Waterbird reproductive depredation
Hillview	Year-around-continuous or "as needed" (July 1993 to March 31, 2012)	Bird deterrent overhead wire system, bird harassment (pyrotechnics, propane cannons, physical chasing), small mammal management, alewife collections, bird netting for terrestrial bird management (swallows, sparrows, etc.) and duck management

*Indicates reservoir mitigation only occurs "as needed" under the Final 2007 FAD, Section 4.1.

In response to entrainment of Alewives (*Alosa pseudoharengus*), a baitfish, into the water intake structures at Ashokan Reservoir and their subsequent outflow at Kensico Reservoir, DEP's Waterfowl Management contractor installed a temporary collection boom around the Catskill Influent structure (CATIC) to remove the dead fish that collected at the boom. Collection of Alewives is also conducted as needed at Hillview Reservoir. Alewives are an attractive food source for gulls and some species of ducks and when large numbers of fish are flushing into the reservoir, making the birds very difficult to manage.

Waterbird Reproductive Management

Canada Geese and Mute Swan egg and nest depredation techniques were conducted during the spring and summer periods of 2011 to help reduce fecundity at critical NYC reservoirs. Mitigative actions included Canada Geese reproductive management and maintenance of meadow vegetation (Kensico and Rondout) and shoreline fences (Kensico), where applicable. Egg and nest-depredation involved locating all Canada Geese and Mute Swan (*Cygnus olor*) nests within NYC reservoir property, numbering each nest and egg, and puncturing each egg with a probe to break the membranes thereby destroying the embryo. Eggs were then replaced in the nest to allow incubation to continue unsuccessfully. A small number of goose nests are often destroyed late in the breeding season to encourage the birds to relocate off reservoir property during the annual post-nuptial molt when the birds are rendered flightless for a few weeks.

A total of 65 Canada Goose nests containing 278 eggs were depredated (punctured) at six New York City Reservoirs (Table 4) during the spring of 2011 compared to 75 nests and 392 eggs in the previous year. There was no goose or swan breeding activity recorded at Hillview. All depredation activity was conducted under the terms of Federal Permit (#RG-01040A) from the United States Department of the Interior, United States Fish & Wildlife Service for Canada Geese and a DEC permit (#3-11-100) for Mute Swans.

Additionally, DEP conducted Canada Geese banding in Westchester County to track local movements throughout the NYC watersheds. Band identifications provide a means to identify local breeding, feeding, and loafing areas which may aide in implementing best management practices (i.e. elimination of feeding areas may eliminate presence on reservoirs).

Table 4. 2011 Canada Geese and Mute Swan nest census and egg-depredation.

Reservoir	Number of Surveys	Canada Geese/Mute Swan Nests	Canada Geese/Mute Swan Eggs Depredated	Canada Geese/Mute Swan Depredation Success Rate
Kensico	6	26/1	142/6	98 percent (3 goslings)/100 percent (0 cygnets)
West Branch	4	12/0	45/0	90 percent (5 goslings)/NA
Rondout	1	2/0	0/0	*NA percent (16 goslings)/NA
Ashokan	1	3/0	4/0	21 percent (15 goslings)/NA
Croton Falls	4	12/0	55/0	95 percent (3 goslings) /NA
Cross River	5	10/0	32/0	100 percent/NA
Hillview	91	0/0	0/0	NA/NA

*Nest depredation for Canada Geese was restricted due to nesting Bald Eagles.

RESULTS and DISCUSSION

1. Kensico Reservoir

Kensico Reservoir receives water from Rondout and West Branch Reservoirs via the Delaware Aqueduct and from the Ashokan Reservoir via the Catskill Aqueduct. Water leaving Kensico is disinfected with chlorine and delivered via aqueduct to Hillview Reservoir. Kensico Reservoir has been divided into eight Bird Zones to compare bird counts with water samples collected at limnological sampling locations. Waterbird numbers at Kensico Reservoir remained consistently low throughout the reporting period as a result of continued implementation of the Waterfowl Management Program (Figure 1). The geographic configuration of Kensico includes two main open water areas; one in Bird Zone 4 and one in Bird Zone 6 (Figure 38). These open water areas tend to attract large numbers of gulls roosting overnight.

Prior to implementing bird harassment, DEP began collecting bird census data in August of 1992. Bird counts reached several thousand during the migratory/wintering period (Figure 1) with high bird roosting counts recorded in the water intake coves at Kensico. Figure 1 shows a dramatic decline in bird counts from several thousand in 1994 to a few hundred during the same migratory period in recent years with bird harassment techniques employed. Fecal coliform bacteria show a dramatic decline simultaneous with the inception of the bird harassment efforts, and this observation (or effect) continues through the present day (Figure 2).

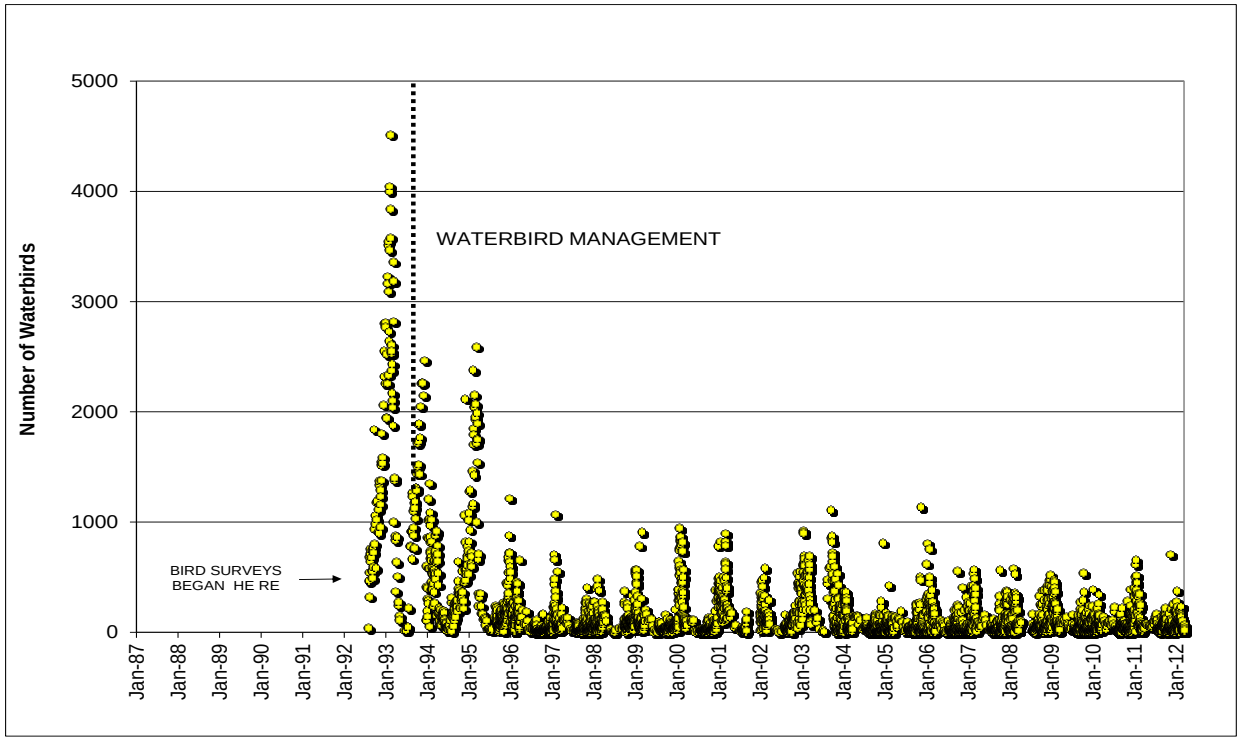

Figure 1. Kensico Reservoir waterbird totals.

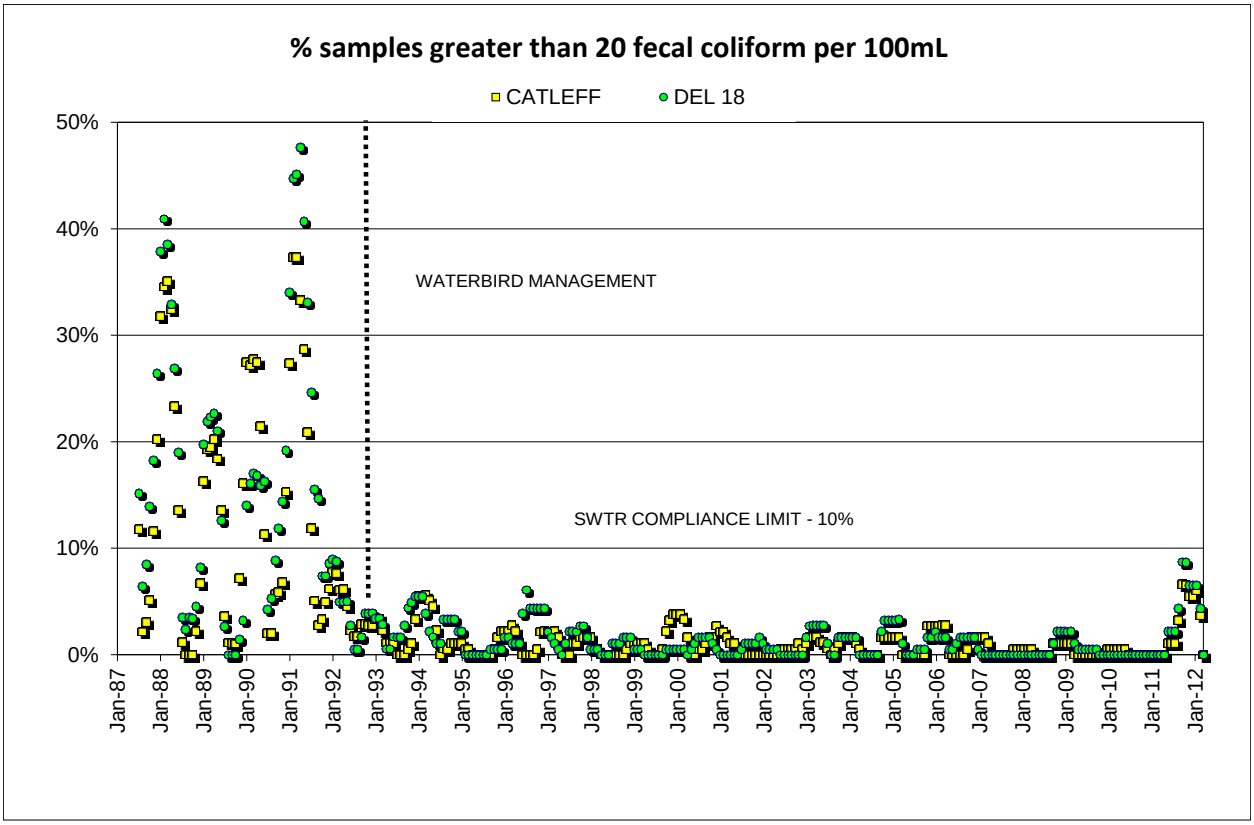

Figure 2. Kensico Reservoir Surface Water Treatment Rule compliance (fecal coliforms 100mL^{-1} at DEL18 and CATLEFF).

The WMP continued to maintain a high level of success from April 1, 2011 through March 31, 2012 managing waterbirds on select NYC reservoirs. This was demonstrated by full compliance with the SWTR requirements for fecal coliform in raw water, which requires that no more than 10 percent of source water samples exceed 20 fecal coliforms 100mL^{-1}. This is reasonably possible when resident and migratory waterbird populations are kept at low levels (Figure 1). Figures 3 and 5 compare the regulatory source water samples collected from DEL18 and CATLEFF (the Kensico effluents) with respect to fecal coliform bacteria and reservoir bird counts. From April 1, 2011 through March 31, 2012 the maximum monthly percentage of source water sample results above 20 fecal coliforms 100mL^{-1} were 8.7 percent for DEL18 and 6.6 percent for CATLEFF (Figure 2). These unusually high maximum percentages are best attributed to unprecedented flooding and runoff related to Tropical Storms Irene and Lee. For comparison there were no water samples collected at the DEL18 or CATLEFF water intakes that exceeded the SWTR limit of 20 fecal coliform 100mL^{-1} in the 2010/2011 reporting period (Figures 4 and 6).

Table 5. Double-digit (>=10) fecal coliform 100mL^{-1} results, precipitation events, and bird counts at Kensico Reservoir keypoint water sampling locations.

Date	DEL18 Fecal coliform 100mL^{-1}	CATLEFF Fecal coliform 100mL^{-1}	Precipitation within 3 days of event (inches rounded to the nearest tenth)	Bird Counts on or before sample date	
				Reservoir-wide totals	Bird Zones 2,3,4 totals
04/18/2011	-	11	3.6	45 on 4/13/11	9 on 4/13/11
04/19/2011	-	10	0.6	45 on 4/13/11	9 on 4/13/11
05/18/2011	**22**	10	2.6	64 on 5/11/11	8 on 5/18/11
05/19/2011	**22**	14	4.5	64 on 5/11/11	8 on 5/18/11
05/20/2011	**23**	**38**	4.4	64 on 5/11/11	8 on 5/18/11
05/21/2011	16	15	2.9	64 on 5/11/11	8 on 5/18/11
05/22/2011	**26**	**21**	0.2	64 on 5/11/11	8 on 5/18/11
05/23/2011	16	11	0.2	64 on 5/11/11	8 on 5/18/11
05/26/2011	10	12	0.3	60 on 5/25/11	14 on 5/25/11
06/24/2011	16	11	3.0	60 on 6/22/11	13 on 6/22/11
06/26/2011	-	14	0.1	60 on 6/22/11	13 on 6/22/11
06/27/2011	19	13	0.0	60 on 6/22/11	13 on 6/22/11
06/28/2011	11	12	0.5	60 on 6/22/11	13 on 6/22/11
06/29/2011	12	-	0.5	96 on 6/29/11	50 on 6/29/11
08/13/2011	13	-	0.1	11 on 8/13/11	8 on 8/13/11
08/28/2011[b]	**53**[a]	**150**[a]	7.1	9 on 8/27/11	0 on 8/27/11
08/29/2011[b]	**70**	**TNTC**[a]	7.1	9 on 8/27/11	0 on 8/27/11
08/30/2011	**49**	**30**	5.7	47 on 8/30/11	45 on 8/30/11
08/31/2011	**39**	**42**	0.0	51 on 8/31/11	44 on 8/31/11
09/01/2011	**37**	**42**	0.0	52 on 9/1/11	44 on 9/1/11
09/02/2011	15	**27**	0.0	50 on 9/2/11	17 on 9/2/11
09/03/2011	10[a]	10	0.0	8 on 9/3/11	2 on 9/3/11
09/07/2011	**39**	**40**	4.1	72 on 9/7/11	57 on 9/7/11
09/08/2011	**42**	**760**	6.2	43 on 9/8/11	1 on 9/8/11
09/09/2011	**150**	**58**	2.9	45 on 9/9/11	30 on 9/9/11
09/10/2011	**33**	·	2.1	10 on 9/10/11	8 on 9/10/11
09/11/2011	**27**	**36**	0.0	20 on 9/11/11	10 on 9/11/11
09/12/2011	**29**	20	0.0	145 on 9/12/11	55 on 9/12/11
09/28/2011	11	-	0.4	47 on 9/28/11	45 on 9/28/11
09/30/2011	**37**	-	2.2	134 on 9/30/11	130 on 9/30/11
10/01/2011	17	-	2.1	103 on 10/1/11	100 on 10/1/11
10/02/2011	11	-	0.9	93 on 10/2/11	5 on 10/2/11

[a] Laboratory notes

[b] No surveys or bird harassment due to Tropical Storm Irene

Bold indicates FCOLI above 20 CFU/100 mL

· indicates Laboratory note

There were three important precipitation events recorded during 2011 that coincided with elevated fecal coliform counts that were observed in May, August, and September (Table 5). During the spring 2011 precipitation event (May 15-18, 2011), over 5 inches of rain was recorded resulting in six consecutive double-digit fecal coliform results at DEL18 (collected May 18-23, 2011), four of which were above 20 fecal coliforms $100mL^{-1}$ (Figure 4). There were also six double-digit fecal coliform sample results at CATLEFF from May 18 through May 23, two of which were above 20 fecal coliforms $100/mL^{-1}$ (Figure 7). In late August and early September 2011, the region was struck by Tropical Storms Irene and Lee. Over seven inches of rain was recorded during Tropical Storm Irene on August 27-28, 2011. This storm resulted in seven double-digit fecal coliform bacteria sample results at DEL18 from August 28 through September 3, 2011, five of which were above 20 fecal coliforms $100mL^{-1}$. There were also seven double-digit fecal coliform bacteria sample results at CATLEFF from August 28 through September 3, 2011, six of which were above 20 fecal coliforms $100mL^{-1}$ (Table 5). Rainfall associated with Tropical Storm Lee in early September totaled 6.2 inches at Kensico. During the time period of September 6 to September 8, 2011, six samples from DEL18 and four samples from CATLEFF were above 20 fecal coliforms $100mL^{-1}$. There were no elevated fecal coliform counts recorded at either DEL18 or CATLEFF from the beginning of October 2011 through March 31, 2012.

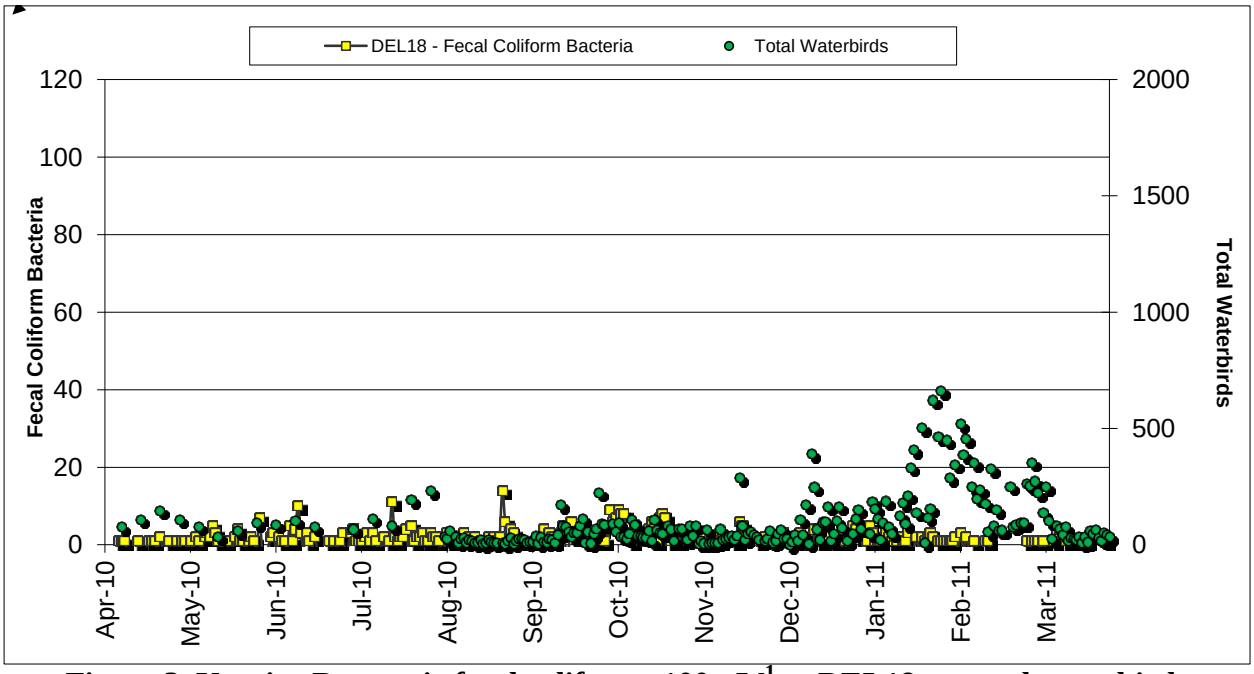

Figure 3. Kensico Reservoir fecal coliforms $100mL^{-1}$ at DEL18 vs. total waterbirds (4/1/2010 to 3/31/2011).

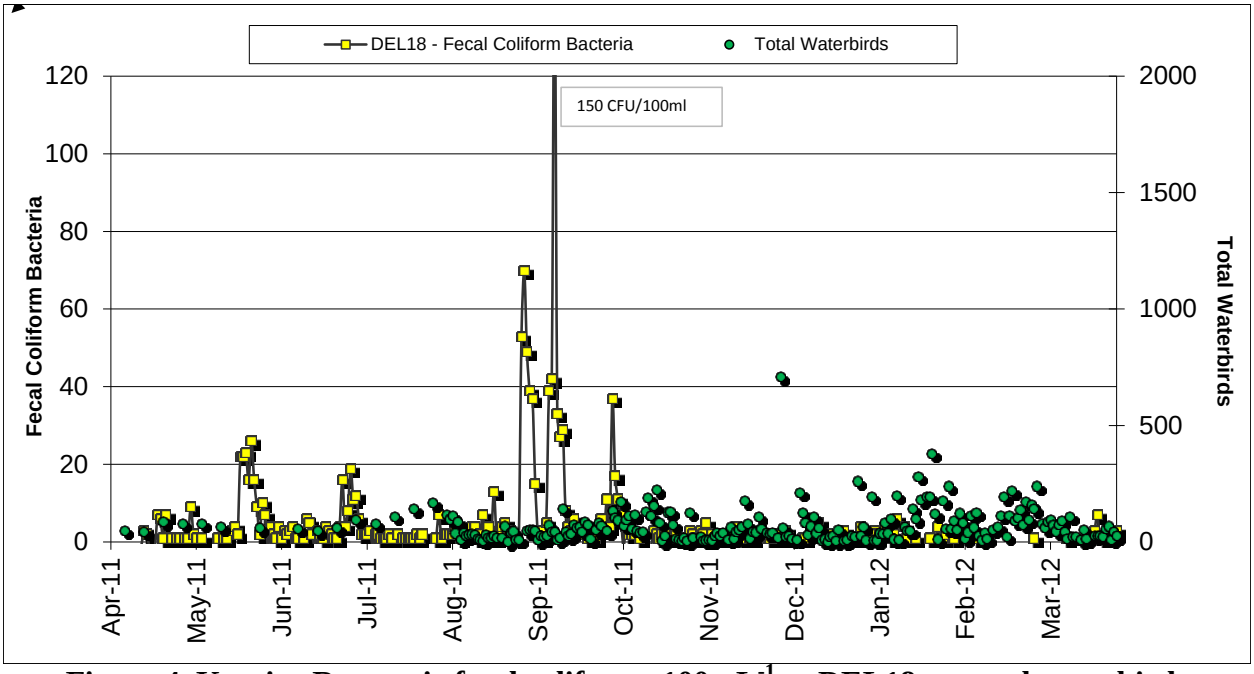

Figure 4. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18 vs. total waterbirds (4/1/2011 to 3/31/2012).

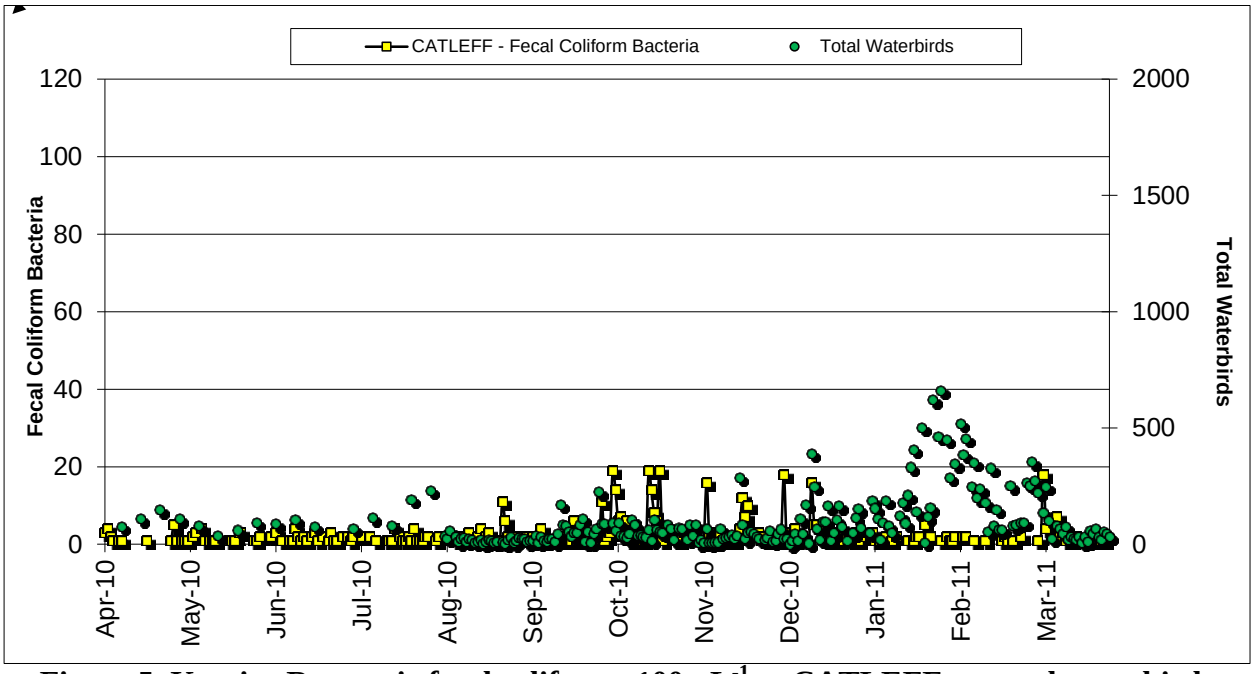

Figure 5. Kensico Reservoir fecal coliforms 100mL^{-1} at CATLEFF vs. total waterbirds (4/1/2010 to 3/31/2011).

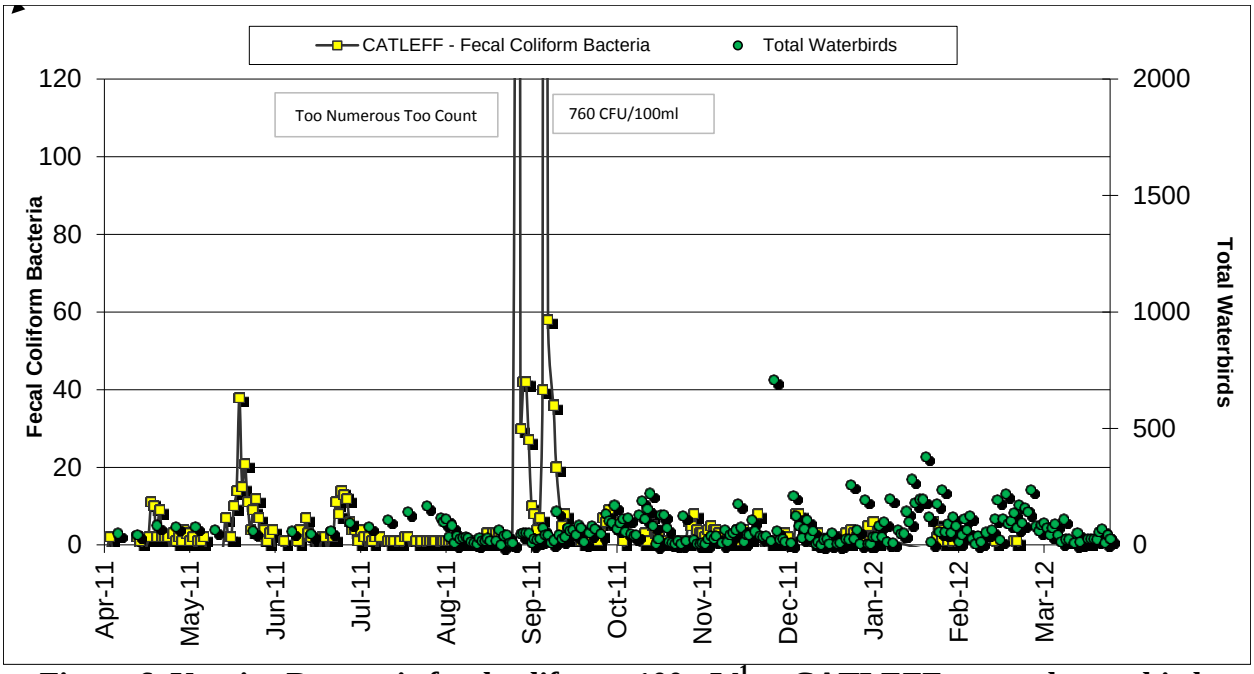

Figure 6. Kensico Reservoir fecal coliforms 100mL^{-1} at CATLEFF vs. total waterbirds (4/1/2011 to 3/31/2012).

Reservoir-wide waterbird counts remained relatively low throughout the waterbird harassment period (August 1 to March 31) averaging about 69 birds per night survey and spiking at 708 (611/708 were gulls) on November 30, 2011 compared to an average of 93 birds/night in 2010/2011 (Figures 7 and 8). In Bird Zone 2, closest to Delaware Shaft 18 (DEL18), waterbirds were observed 15 times in 2011/2012, six of which were observed during the harassment period compared to 36 days in the previous year (Figure 9). A high count of 13 Canada Geese was observed in Bird Zone 2 on June 8, 2011, eight of which were removed under a Westchester County Airport contract with USDA later in the season. In Bird Zone 3, closest to the Catskill Effluent (CATLEFF), birds were observed on seven surveys, three of which were recorded during the active harassment period compared to seven in 2010/2011. The high count of birds for Zone 3 was 17 Canada Geese on June 1, 2011 (Figure 10). There were two observations of birds over 200 in Bird Zone 4 closest to the NYC Kensico outflows (DEL 18 and CATLEFF), but this was higher than the two observed in 2010/2011 (Figure 11). The high count of 375 birds in Zone 4 occurred on November 30, 2011 and was probably a result of the DEP contractor decision to resort to shoreline hazing while suspending boat harassment operations due to heavy fog conditions on the afternoon of November 29, 2011.

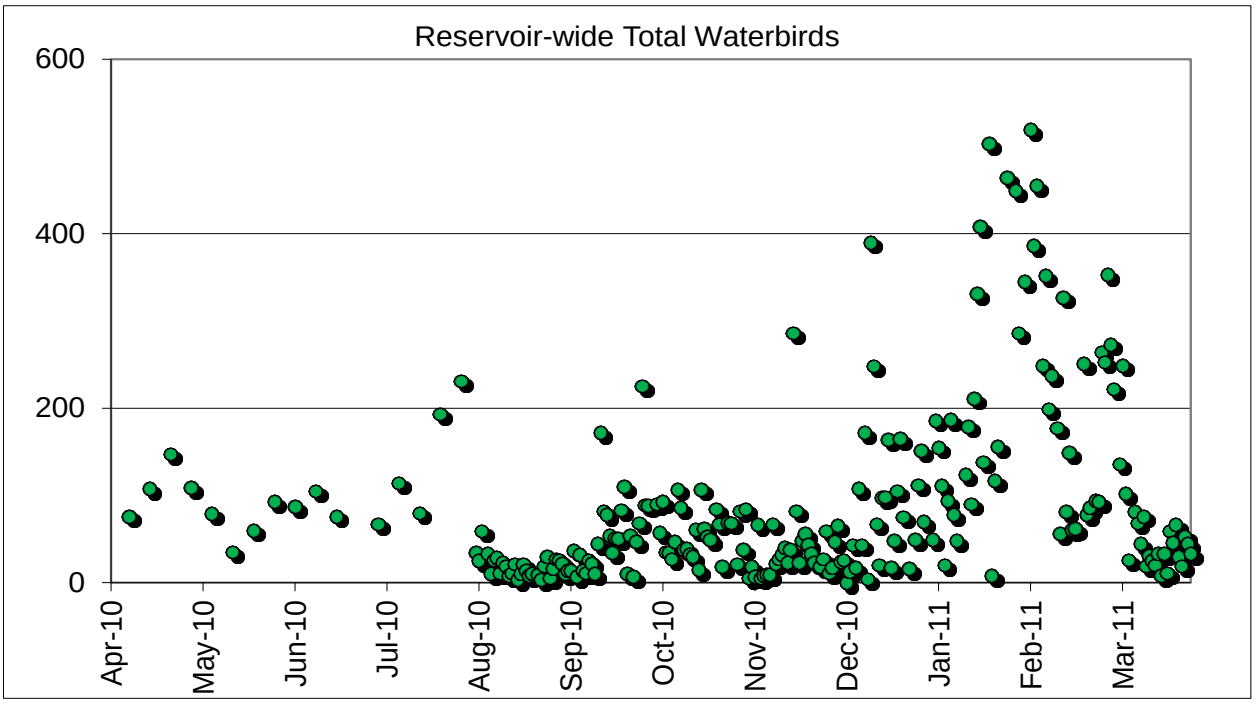

Figure 7. Kensico Reservoir total annual waterbirds (4/1/2010 to 3/31/2011).

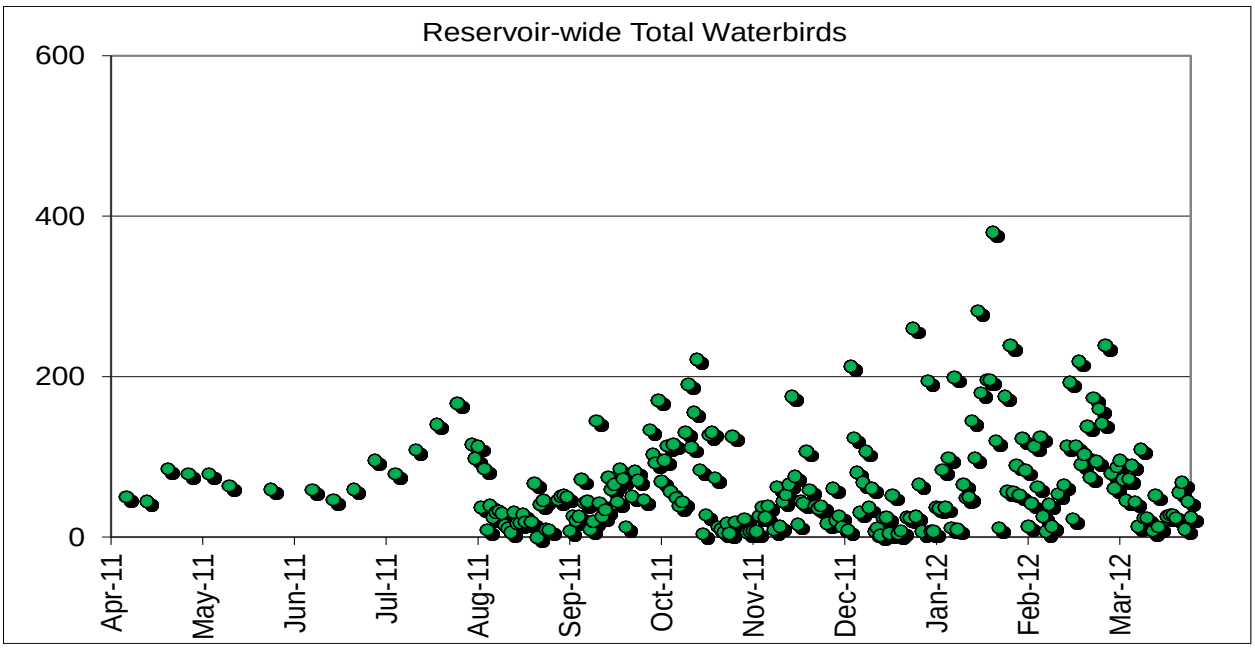

Figure 8. Kensico Reservoir total annual waterbirds (4/1/2011 to 3/31/2012).

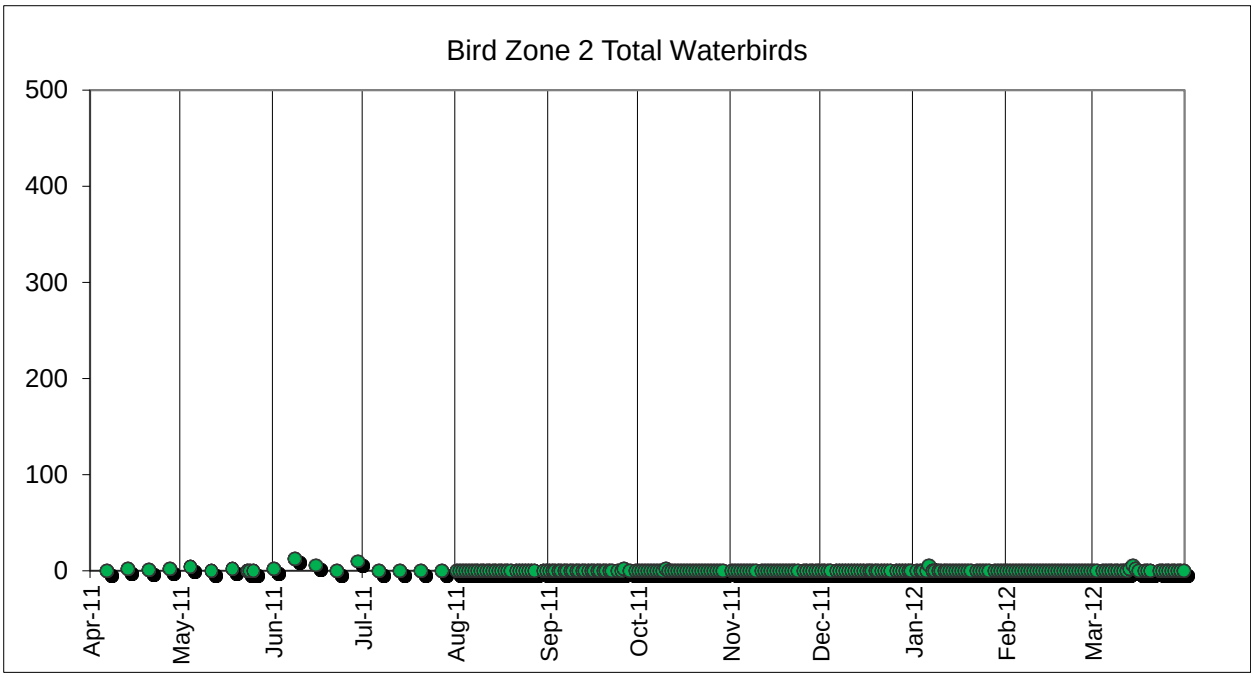

Figure 9. Kensico Reservoir Bird Zone 2 waterbirds (4/1/2011 to 3/31/2012).

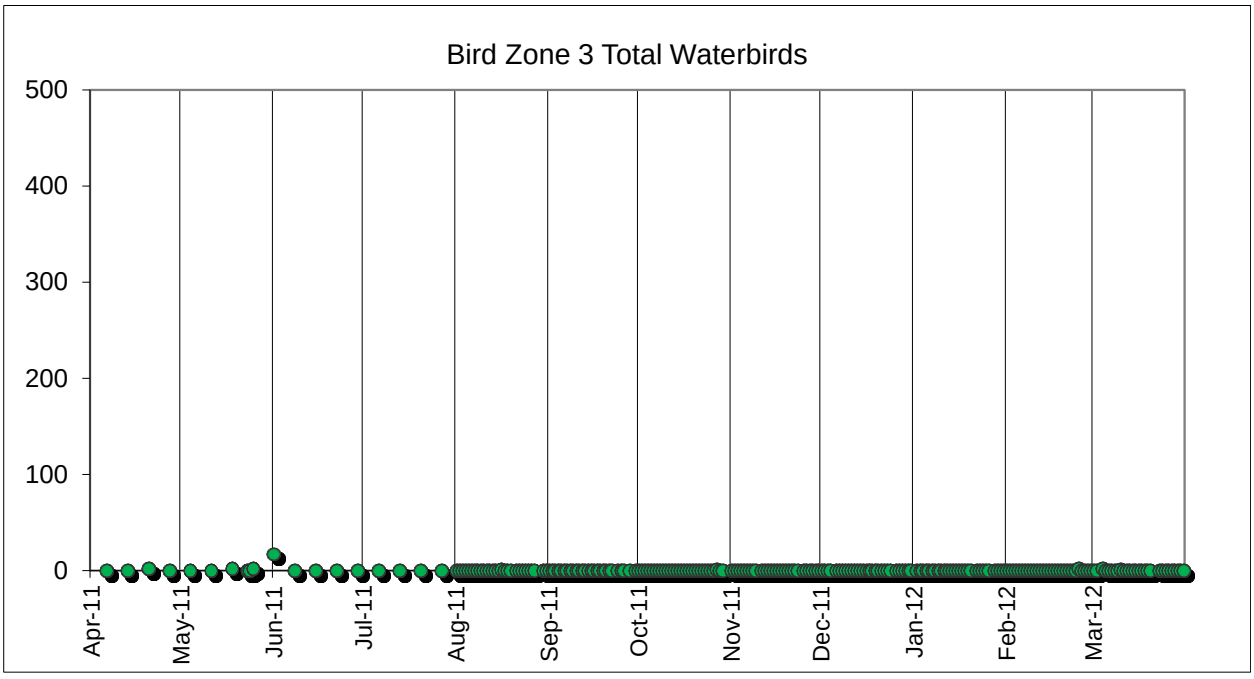

Figure 10. Kensico Reservoir Bird Zone 3 waterbirds (4/1/2011 to 3/31/2012).

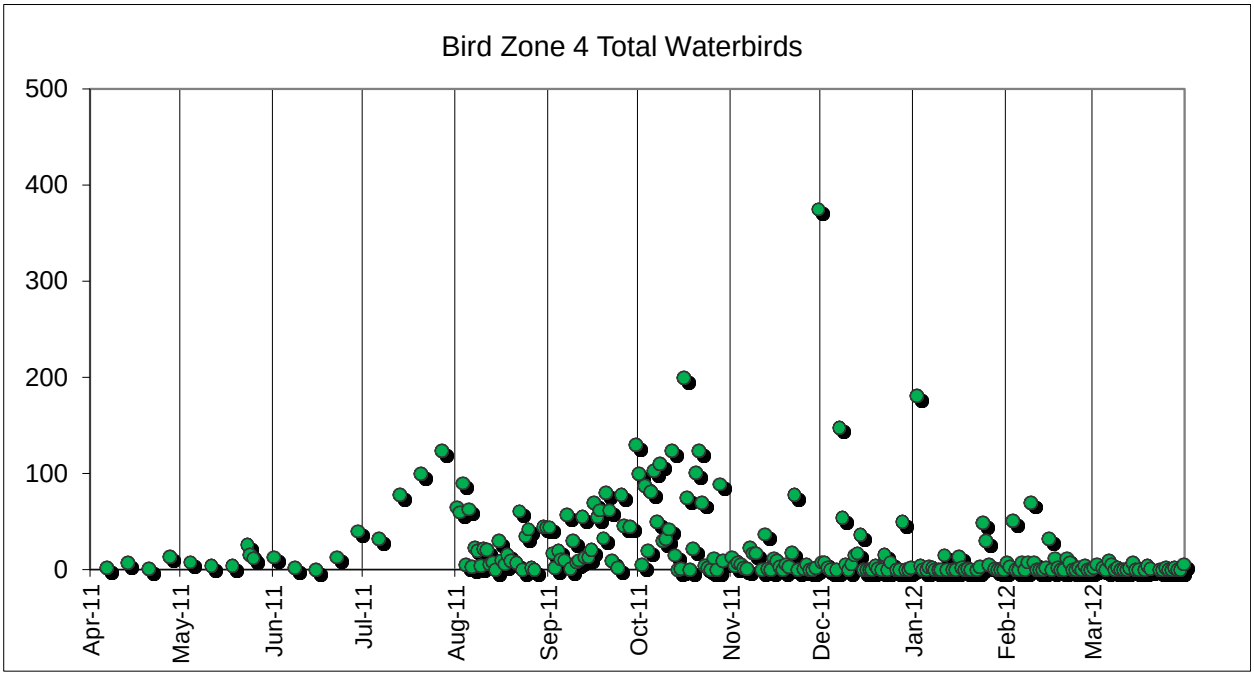

Figure 11. Kensico Reservoir Bird Zone 4 (4/1/2011 to 3/31/2012).

This importance of specific groups of waterbird groups continues to follow annual migration, over-wintering patterns, and extent of ice-cover. During 2011/2012 gull numbers persisted throughout the winter as there was little to no ice cover. Duck counts appeared to be lower and Canada Geese remained low, which may be a result of the Westchester County Airport goose depredation work (Figures 12-13). Reservoir ice-cover was minimal and only observed in reservoir cove areas in parts of January and February 2012.

The Westchester County Airport, located immediately east of the Rye Lake area (Bird Zone 6 in Figure 38) continued to manage birds for air-traffic safety. As part of the airport's Wildlife Hazard Management Plan (Airport Depredation Orders – Resident Canada Goose nest and egg depredation order, 50 CFR 12.50 and Control order for resident Canada Geese at airports and military airfields 50 CFR 12.49), Westchester County has contracted with USDA to remove all Canada Geese within a three-mile radius around the airport property which includes all of the Kensico Reservoir. During this reporting period, DEP allowed USDA and Westchester County Airport access to NYC-owned property to remove the geese. As previously stated during this reporting period eight geese removed from the Kensico Reservoir property as the geese naturally relocated to adjacent properties prior to the molt period.

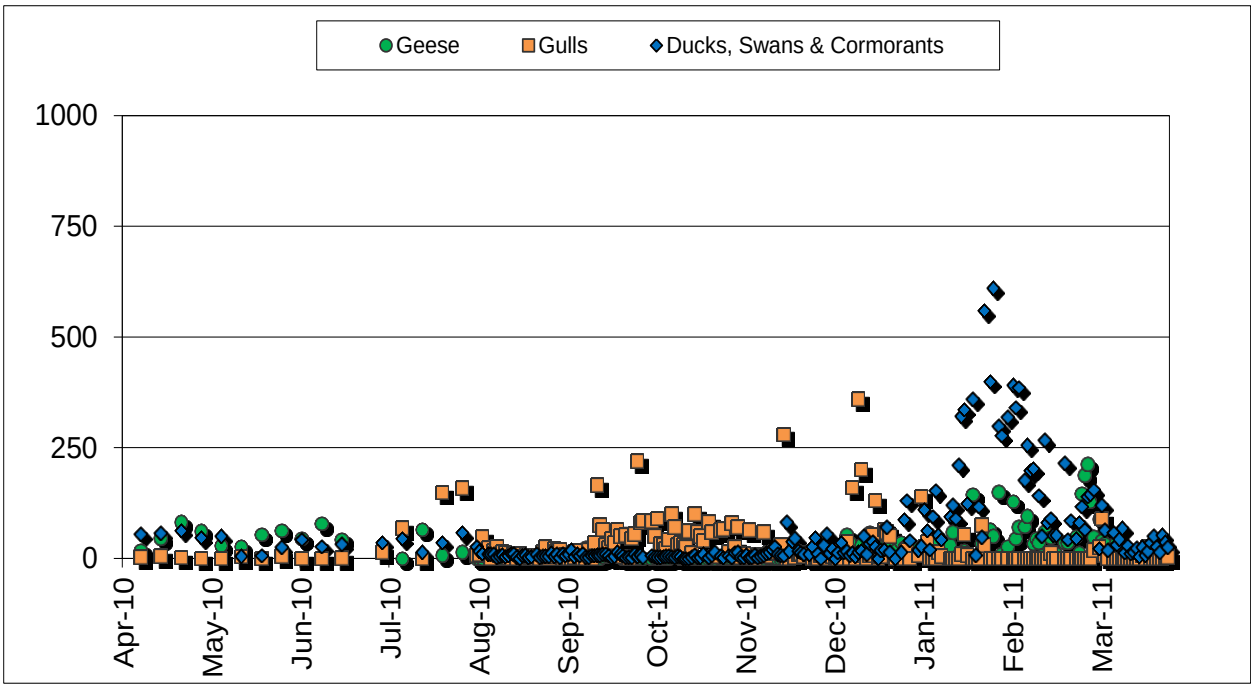

Figure 12. Kensico Reservoir total waterbird groups (4/1/2010 to 3/31/2011).

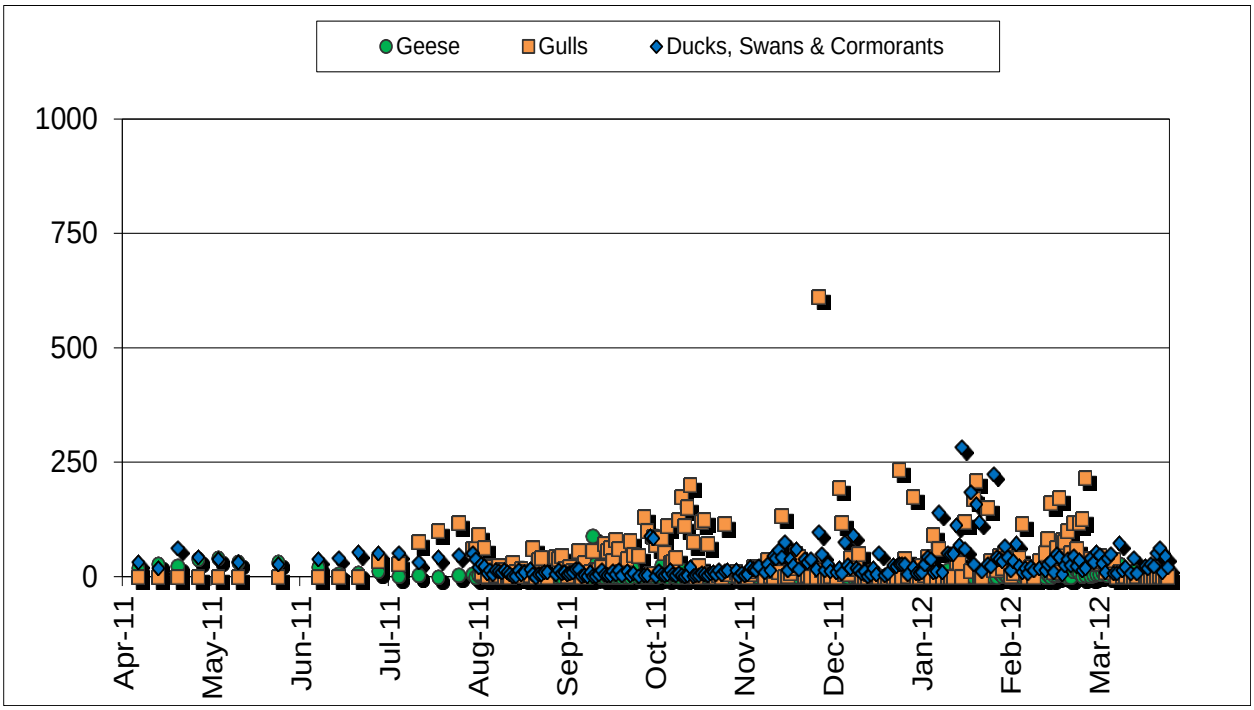

Figure 13. Kensico Reservoir total waterbird by groups (4/1/2011 to 3/31/2012).

It is suspected that the increased spatial separation between birds and the water intake continue to reduce the threat for an increase in fecal coliform bacteria near Delaware Shaft 18 and the Catskill Upper Effluent Chamber. As a result, bird harassment activities are concentrated in the vicinity of the two main water intake facilities. Overall, waterbird numbers continue to be lower throughout Kensico; a direct result of the ongoing bird harassment work.

Alewives (baitfish) flushing through upstate aqueducts to Kensico was once again unremarkable during the autumn/winter period of 2011/2012. When present, the dead and dying alewives typically attract foraging gulls and ducks. DEP and its contractor will continue monitor fish concentrations and collect dead/dying baitfish as they enter Kensico Reservoir. The volume of fish observed, collected and disposed of at the Kensico water CATIC (intake) in 2011/2012 was 115.8 pounds compared to no fish collected in 2010/2011 and 200 pounds collected in 2009/2010.

In the spring of 2011 a total of 26 Canada Geese nests were identified along the reservoir shoreline and on islands. Among the 26 nests, 142 eggs were punctured and replaced back to the nest to allow the nesting geese to continue to incubate (Table 4). The average number of eggs per nest was 5.6 compared to 4.8 in the previous year (DEP 2011). A total of three young goslings were observed rendering the egg depredation success at 98 percent in 2011 similar to the 98 percent success rate in 2010. Adult breeding geese or failed breeders generally disperse from the reservoir prior to the post-breeding season molt which begins in June however if goslings are hatched some of the adults tend to remain at the reservoir during the molt or flightless period which can last three to four weeks.

The Kensico source waters remained in compliance with the SWTR standard for fecal coliform bacteria throughout 2011 (Figure 4). Due to the implementation of the WMP, levels of fecal coliform bacteria have been consistently compliant with the SWTR since 1993.

2. West Branch Reservoir

The 2007 FAD lists West Branch Reservoir as one of five reservoirs covered under the "as needed" criteria for Waterfowl Management. Since the implementation of the WMP, program, only two "as needed" actions have been implemented at West Branch. West Branch Reservoir is divided into four bird survey zones associated with reservoir water quality sampling locations (Figure 39). Migratory and wintering waterbird populations at West Branch were sampled weekly to record annual trends which aids in identifying sources of elevated fecal coliform bacteria levels. In 2011/2012, gulls temporarily increased during the month of July, spiking at 160 on July 19, 2011, but then decreased for the remainder of the reporting period except for 75 counted on November 1, 2011. This compares to a gull counts spike of 1,200 on November 23, 2010 (DEP 2011). Reservoir-wide total birds spiked to 2,027 on November 22, 2011 compared to 6,289 recorded on December 11, 2010 in previous year (Figures 14 and 15). Of the season high of 2,027 birds, 2,021 were ducks. Mild winter conditions throughout the northeast may

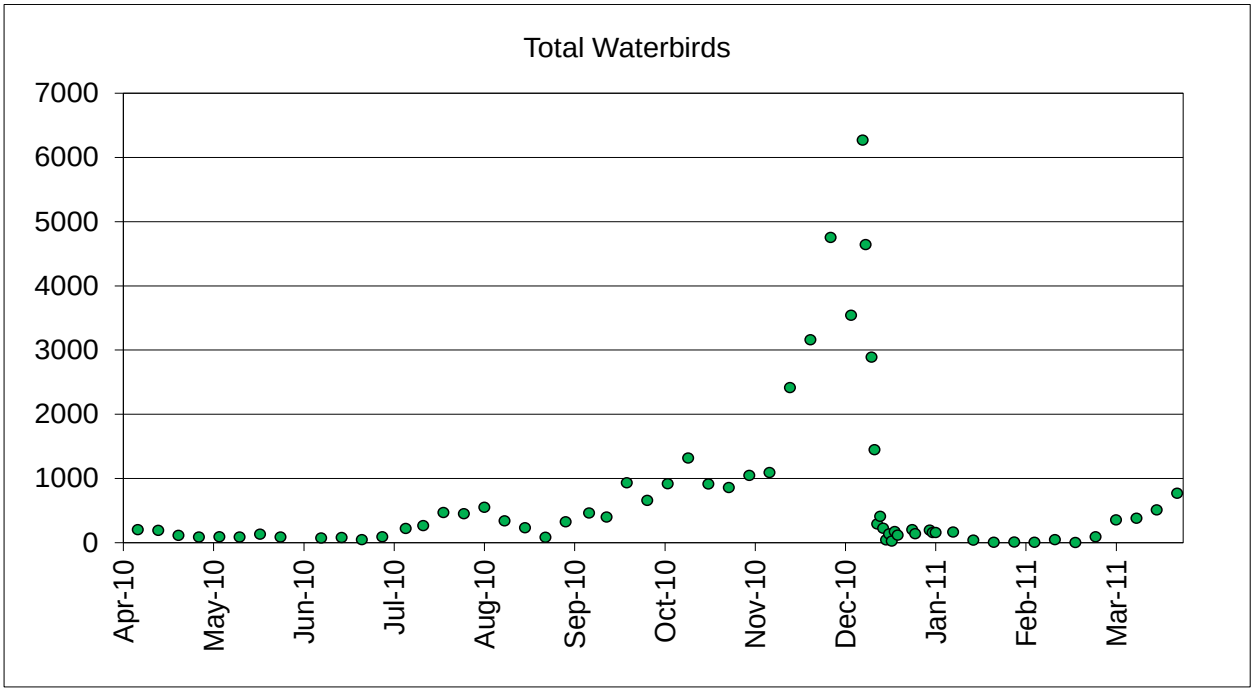

Figure 14. West Branch Reservoir total waterbirds (4/1/2010 to 3/31/2011).

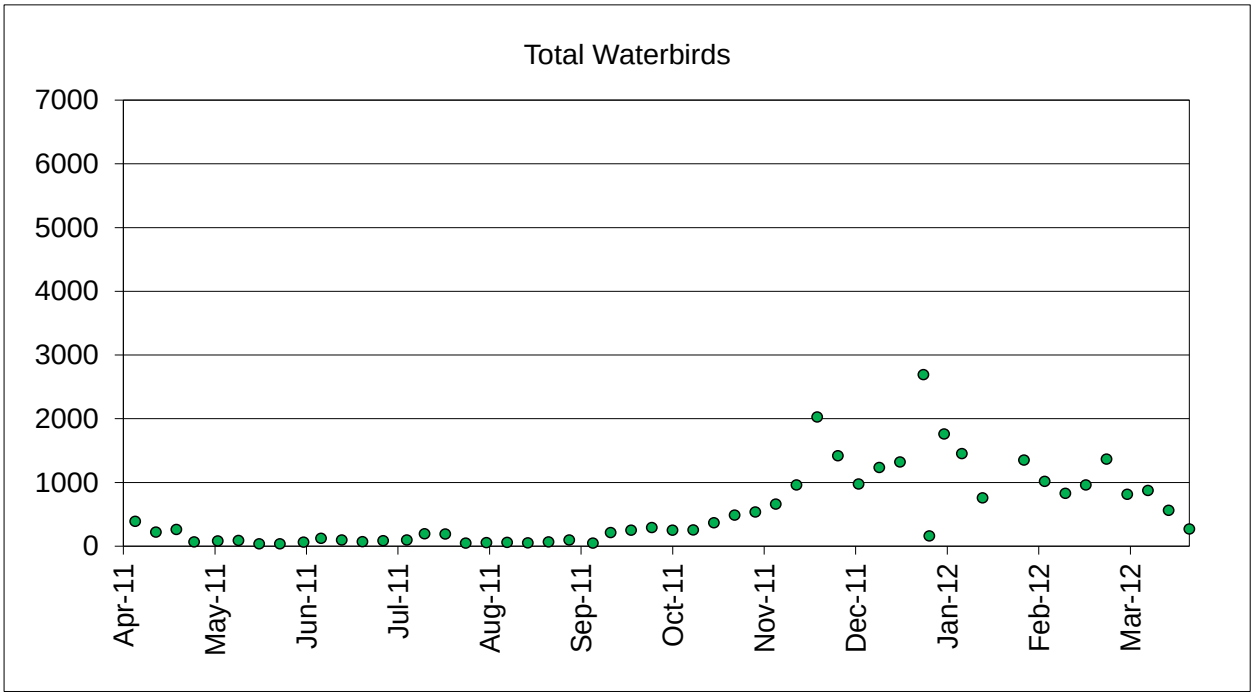

Figure 15. West Branch Reservoir total waterbirds (4/1/2011 to 3/31/2012).

have affected some of the winter gull roost locations in 2011/2012, providing more open freshwater options other than West Branch. Ice cover on the reservoir reached 70 percent coverage by January 16, 2012 and diminished by February 27, 2012.

There were six fecal coliform counts above 20 fecal coliforms $100mL^{-1}$ recorded at the Delaware Shaft 10 (DEL10) water intake on the following dates: August 16, 2011 (48 fecal coliforms $100mL^{-1}$); September 6, 2011 (30 fecal coliforms $100mL^{-1}$); September 29, 2011 (100 fecal coliforms $100mL^{-1}$; September 30, 2011 (57 fecal coliforms $100mL^{-1}$); October 1, 2011 (22 fecal coliforms $100mL^{-1}$); October 2, 2011 (24 fecal coliforms $100mL^{-1}$) (Figure 16). There was no important waterbird population increase associated with the aforementioned elevated bacteria counts (Figure 16). The fecal coliform bacteria increase recorded in late August and early September was coincident with the impacts of Tropical Storm's Irene Lee.

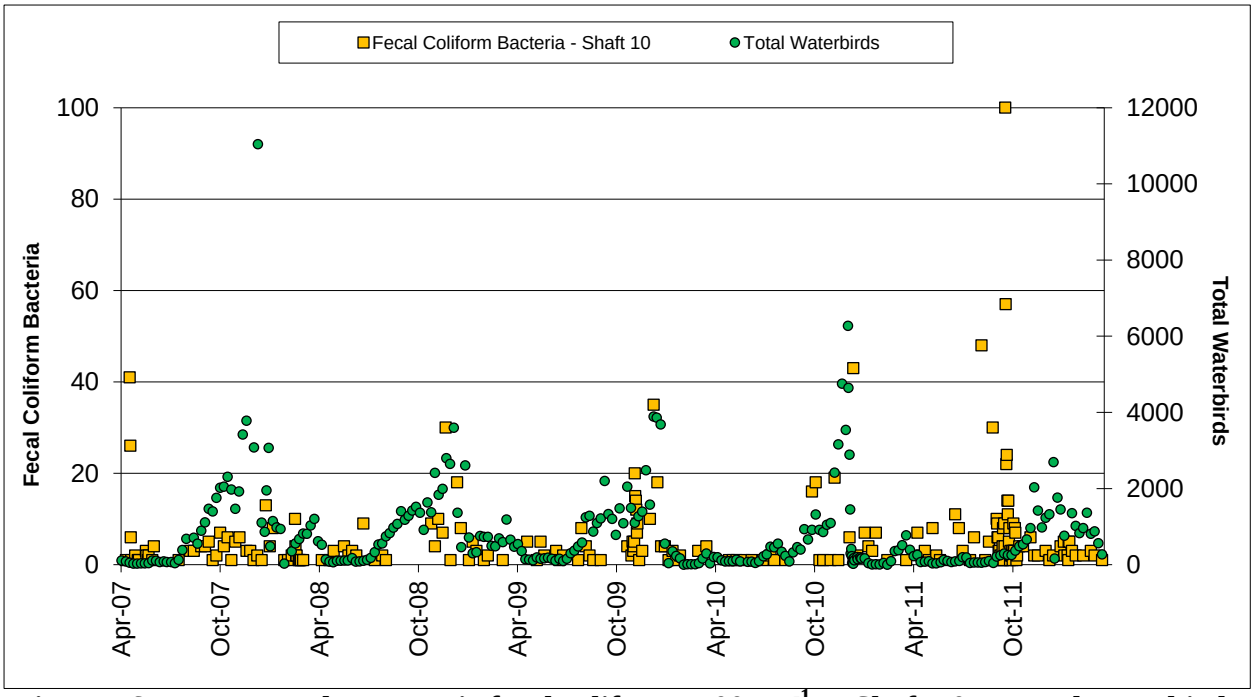

Figure 16. West Branch Reservoir fecal coliforms $100mL^{-1}$ at Shaft 10 vs. total waterbirds (4/1/2007 to 3/31/2012).

DEP conducted reproductive control on Canada Geese from April 1 through May 31, 2011 to reduce productivity at West Branch Reservoir. In 2011, 12 nests and 45 eggs were depredated which was down from the previous year at 12 nests and 42 eggs (Table 4). The egg-depredation was deemed 90 percent successful as there were five goslings documented following the reproductive period. There were no Mute Swans nesting at West Branch in 2011. A small colony of Double-crested Cormorants nested in the spring of 2011 along the eastern shoreline in Bird Zone 3. The nesting colony was located high in an inaccessible shoreline tree.

3. Rondout Reservoir

The Rondout Reservoir is a terminal or source water reservoir to both Kensico and West Branch. Located west of the Hudson River, Rondout is part of the Delaware System of reservoirs. The 2007 FAD lists Rondout as one of five reservoirs covered under the "as needed" criteria for Waterfowl Management. Since the implementation of the WMP, only three "as needed" actions have been implemented at Rondout. The Rondout Reservoir is divided into nine bird sampling geographic zones associated with reservoir water quality sampling locations (Figure 40).

During this reporting period, there were seven fecal coliform raw water samples above 20 fecal coliforms 100mL^{-1} from the Rondout Effluent, six of which were associated with significant precipitation events and not waterbirds. The fecal coliform elevations of 52 fecal coliforms 100mL^{-1} on August 29, 2011, twenty-four fecal coliforms 100mL^{-1} on August 30, 2011, twenty-two fecal coliforms 100mL^{-1} on August 31, 2011, twenty-one fecal coliforms 100mL^{-1} on September 1, 2011, and 33 fecal coliforms 100mL^{-1} on September 2, 2011 recorded at the Rondout Effluent Chamber (REC) were associated with Tropical Storm Irene. On September 7, 2011 another fecal coliform elevation (30 fecal coliforms 100mL^{-1}) was recorded at the REC and was likely associated with Tropical Storm Lee.

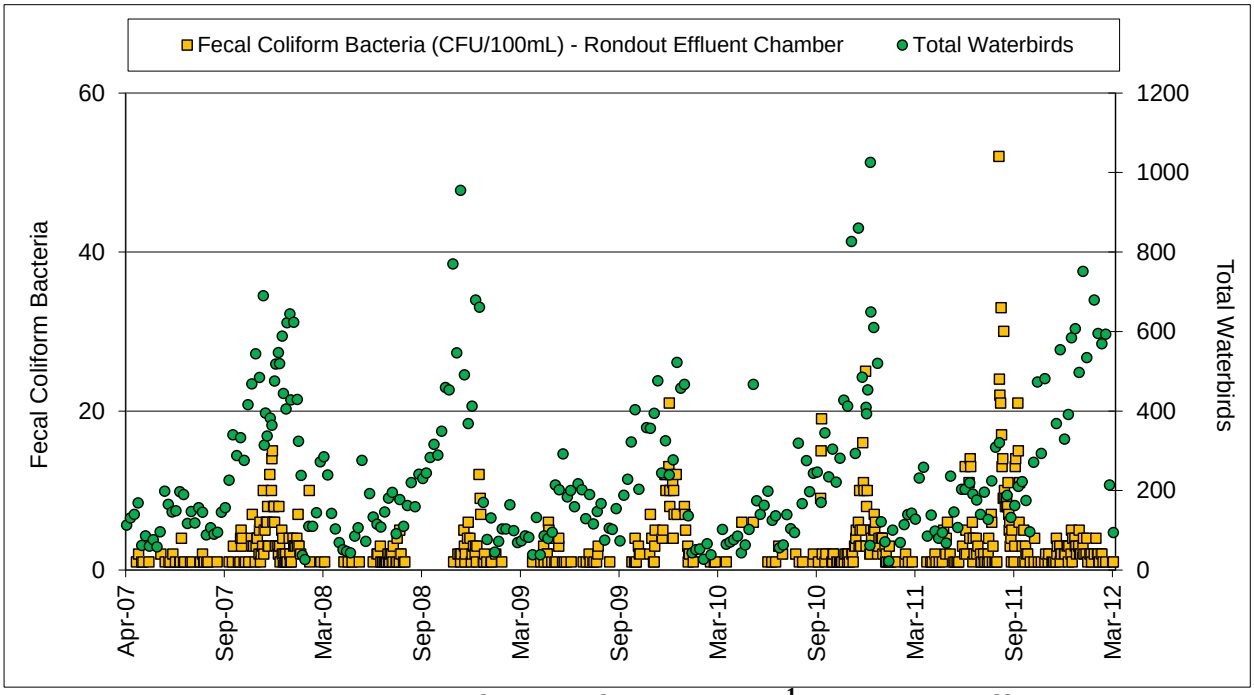

Figure 17. Rondout Reservoir fecal coliforms 100mL^{-1} at Rondout Effluent vs. total waterbirds (4/1/2007 to 3/31/2012).

Canada Goose population counts spiked on June 1, 2011 probably a result of onset of the post-nuptial molt with birds moving to the reservoir environment. A high count of 550 gulls was recorded on February 21, 2012 of which 544 were observed in Bird Zone 2 (Figure 41) in the mid-reservoir region. Duck numbers remained elevated from early November 2011 through mid-March 2012 peaking at 396 on January 17, 2012.

Each year seasonal elevations of waterbirds (mostly gulls and ducks) are recorded at Rondout (Figure 18). Reservoir ice-cover only reached five percent in 2011/2012 which probably allowed continued gull roosting throughout the winter period.

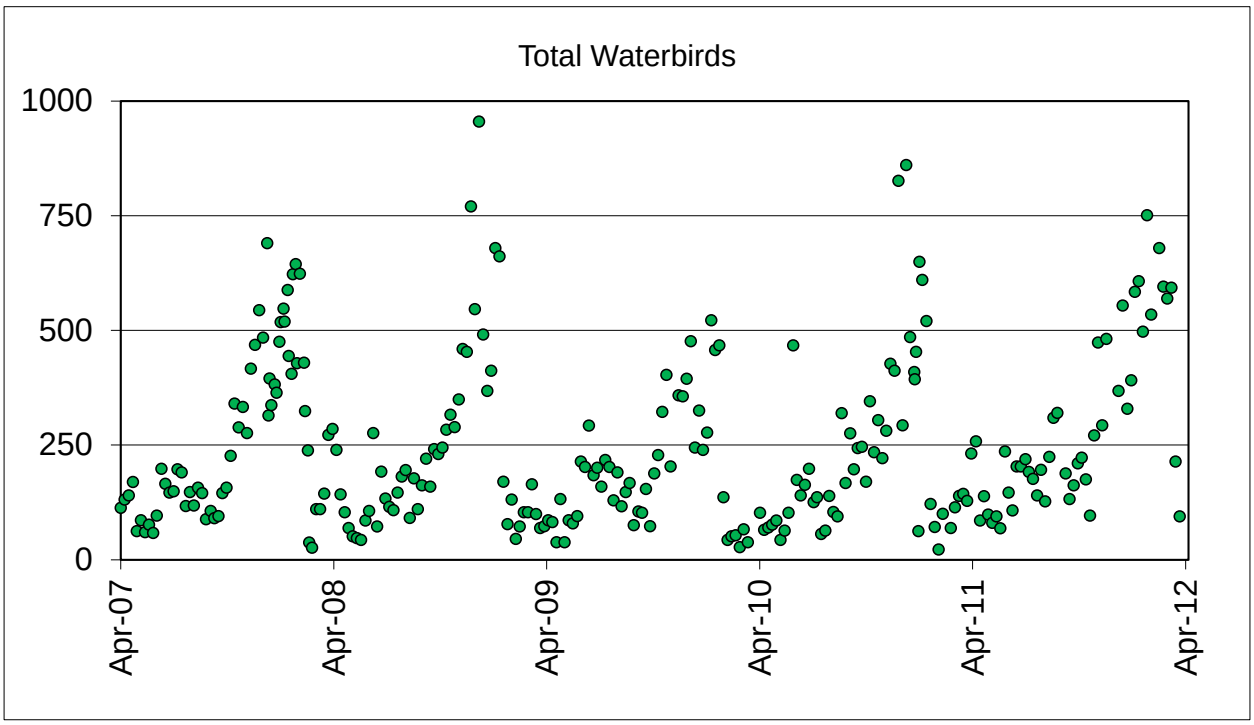

Figure 18. Rondout Reservoir total waterbirds (4/1/2007 to 3/31/2012).

DEP has monitored the spatial distribution of the gull populations at Rondout particularly during the December through January period. In previous years, gulls typically roost at Bird Zone 1; zone closest to the Rondout Effluent Chamber. There does not, however, appear to be a foraging attraction by the birds nor is it due to ice cover restrictions on other parts of the reservoir forcing the birds to roost at the Zone 1 location this time of year. No additional surveys were necessary during this reporting period as there were only three occurrences of gulls roosting in Bird Zone 1 during the winter period. In addition, it was not necessary for DEP to activate its bird harassment program in the 2011/2012 reporting period. The seasonal increase in waterbird populations was similar to the previous year (Figures 19 and 20).

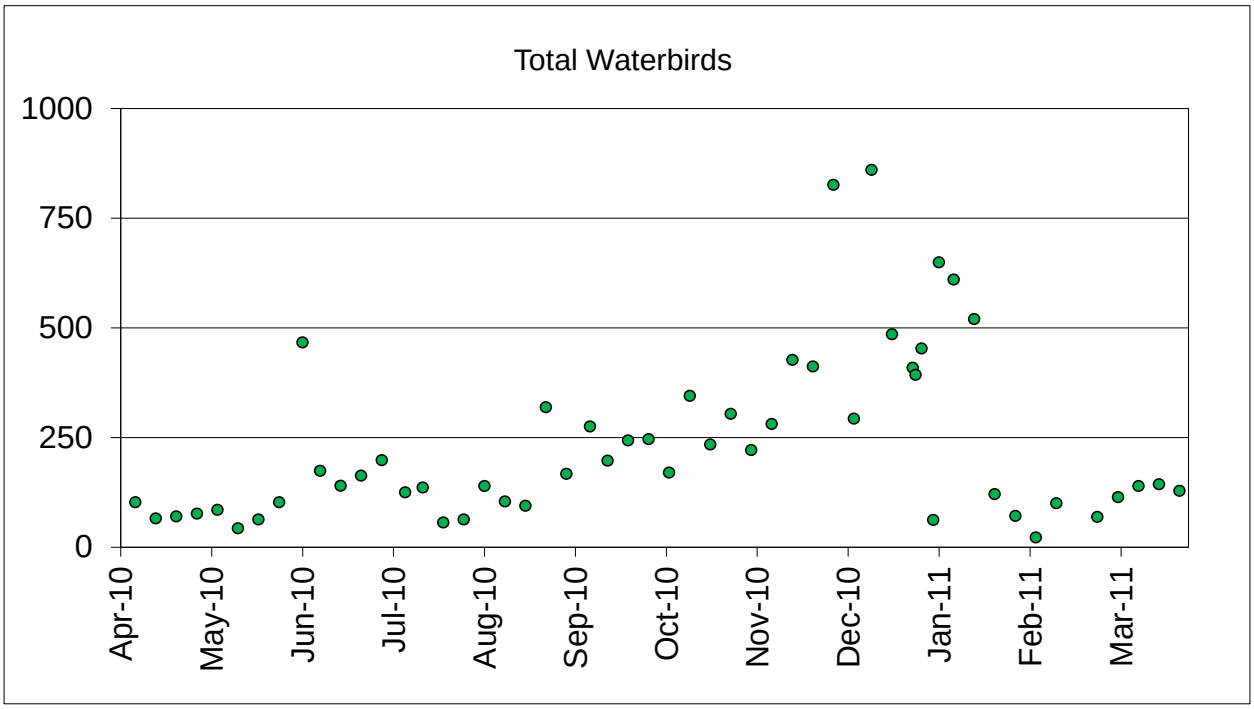

Figure 19. Rondout Reservoir total waterbirds (4/1/2010 to 3/31/2011).

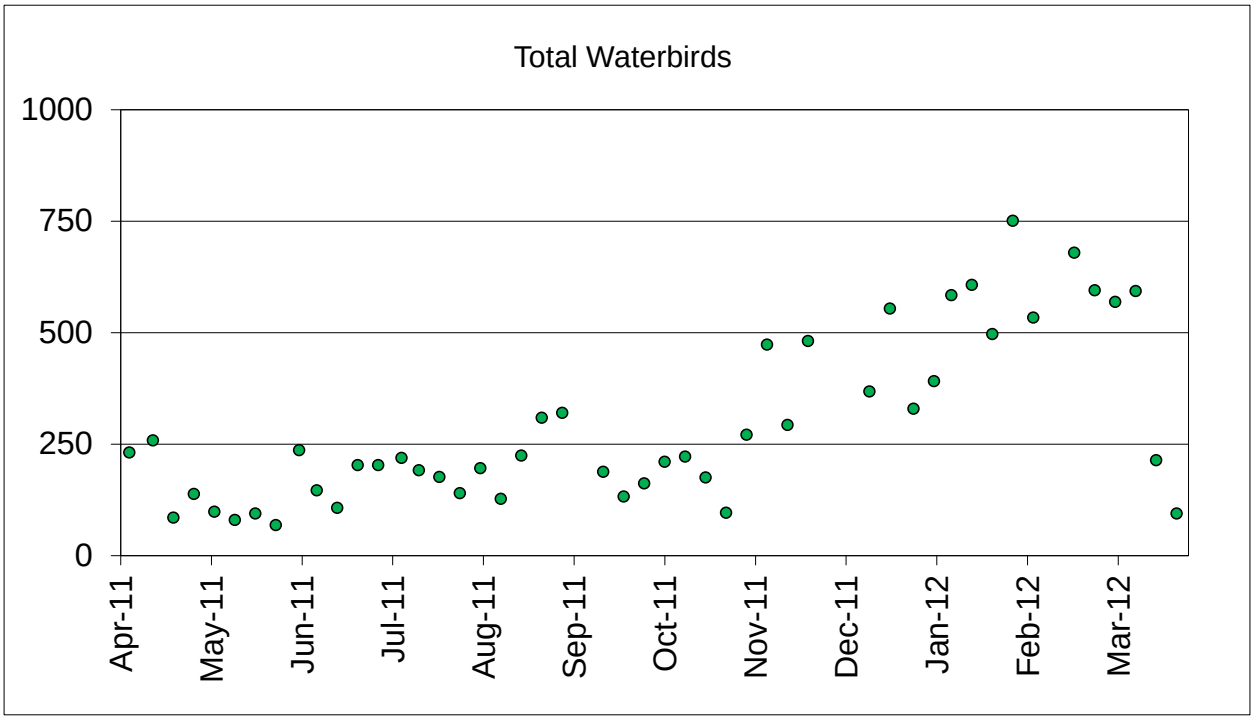

Figure 20. Rondout Reservoir total waterbirds (4/1/2011 to 3/31/2012).

DEP also conducted routine monitoring and maintained full compliance with a protection plan for Bald Eagles (*Haliaeetus leucocephalus*) as required by the DEC and United States Fish and Wildlife Service in preparation for any "as needed" bird harassment activity as stated in the Findings Statement of the Environmental Impact Statement on file.

DEP conducted reproductive control on Canada Geese at Rondout in 2011. Due to the close proximity of some Canada Goose nests to established Bald Eagle nests DEP abstained from some depredation work to maintain compliance with the New York State Endangered Species Protection Laws (Article 11). A total of 16 goslings were documented compared to 21 goslings observed in 2010 (Table 4). There were no Mute Swan nests identified at Rondout in 2011.

4. Ashokan Reservoir

The 2007 FAD lists Ashokan Reservoir as one of five reservoirs covered under the "as needed" criteria for Waterfowl Management. Since the implementation of the WMP, no "as needed" actions have been necessary at Ashokan. The Ashokan Reservoir is divided into two main basins each with a water intake chamber located at the Dividing Weir (Figure 32). There are six waterbird sampling geographic zones, three within each basin and associated with reservoir water quality sampling locations (Figure 41). Overall, bird numbers (particularly gulls) continue to decrease in abundance during the migration and over-wintering period at the Ashokan over the past years (Figure 21). The East Basin (Bird Zones 4, 5, and 6) relative to the West Basin (Bird Zones 1, 2, and 3) of the Ashokan continues to be the primary waterbird roosting area. Total waterbird counts continue to be much lower in recent years when compared to counts in the 1990's and early 2000's preceding the following the closure of two Ulster County landfills (Town of Ulster and Town of New Paltz) which attracted gull foraging activity from the late summer through the winter (Figures 22 and 23).

Gull counts spiked at a count of 1,436 on February 10, 2012 compared to a high count of 1,237 in mid-March 2011. Gulls were largely absent during the winter of 2010/2011 but were present throughout this reporting period probably due to the lack of ice cover. Only about five percent of the reservoir froze in 2011/2012. Canada Geese numbers rose to a high count of 218 on August 5, 2011 compared to 366 on September 3, 2010. The Ashokan West Basin generally has very low bird counts annually compared to the East Basin (Figures 22 and 23).

Duck species, present year-around, reached a peak of 661 on December 2, 2011 compared to a high count of 1,032 recorded on March 25, 2011 in the previous report (DEP 2011).

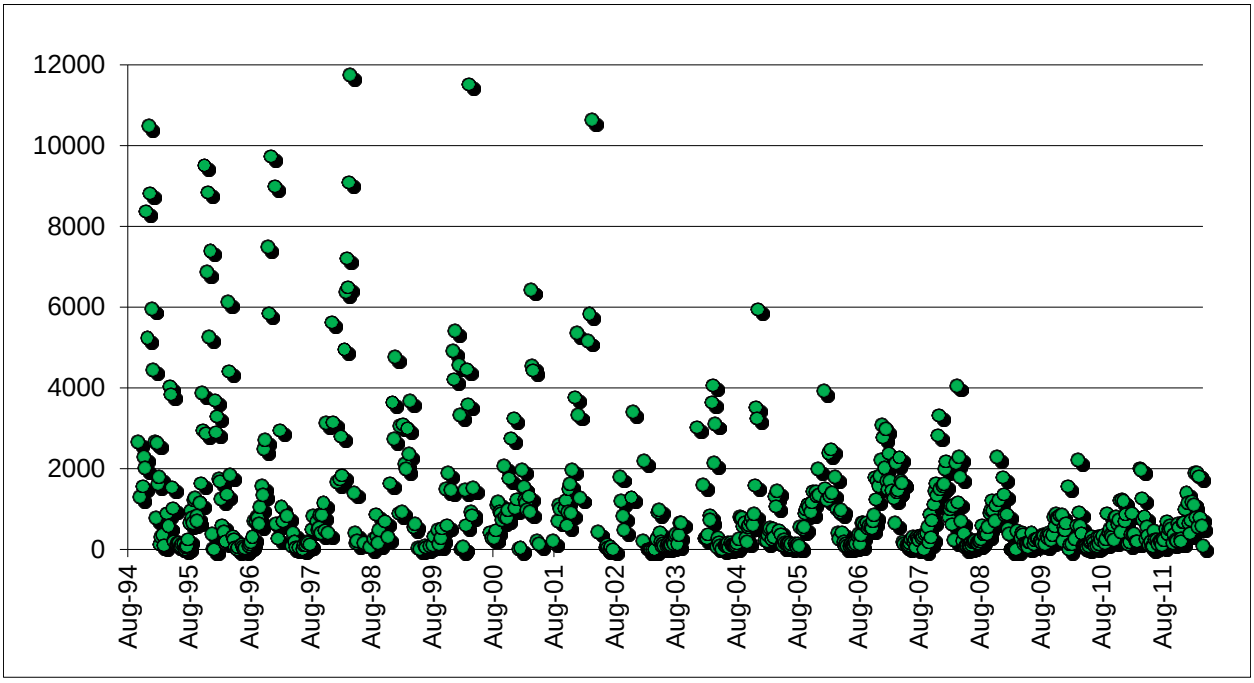

Figure 21. Ashokan Reservoir total waterbirds (1994 to 2012).

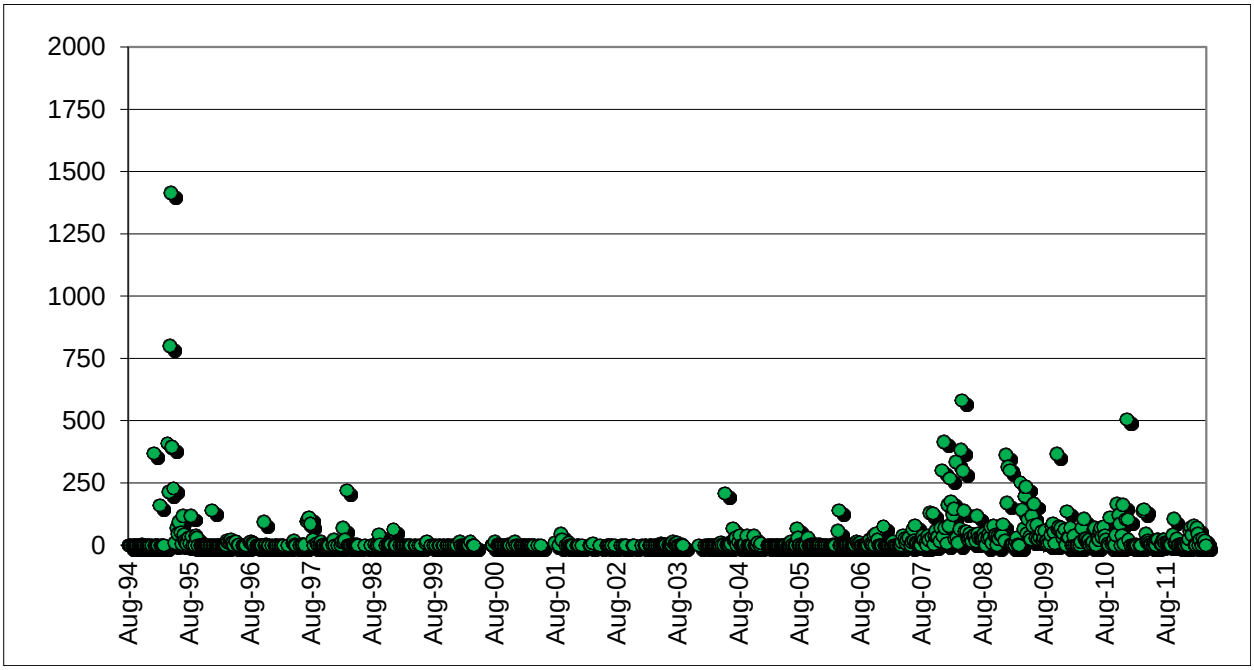

Figure 22. Ashokan Reservoir West Basin total waterbirds in Bird Zones 1, 2, and 3 (1994 to 2012).

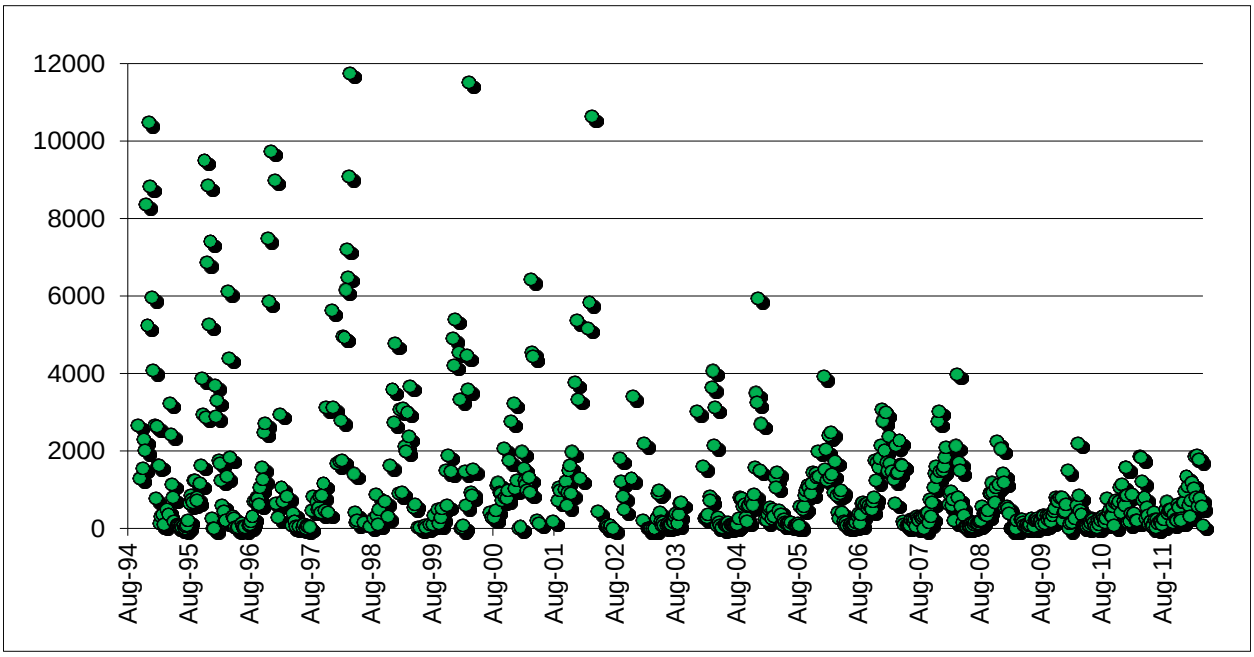

Figure 23. Ashokan Reservoir East Basin total waterbirds in Bird Zones 4, 5, and 6 (1994 to 2012).

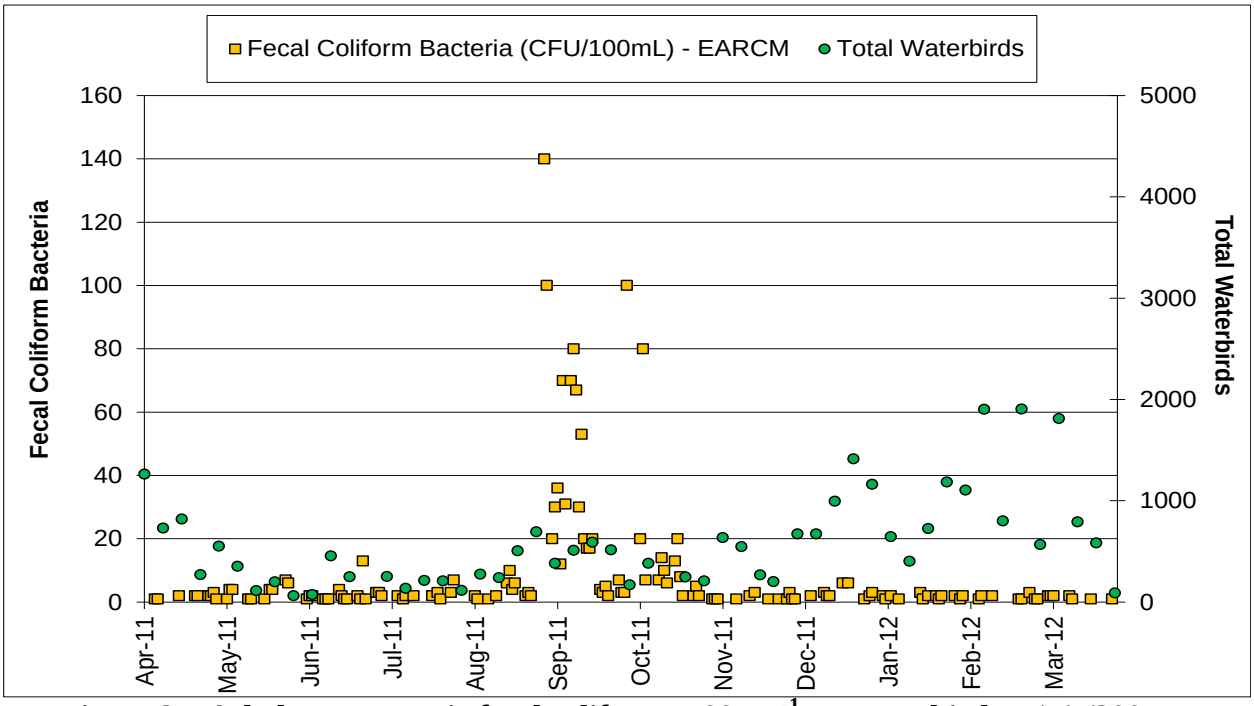

Figure 24. Ashokan Reservoir fecal coliforms 100mL^{-1} vs. waterbirds – (4/1/2007 to 3/31/2012).

Multiple fecal coliform samples collected at the water intake sampling location at Ashokan (EARCM) exceeded 20 fecal coliforms $100mL^{-1}$during August and September of 2011 (Figure 24), as a result of Tropical Storms Irene and Lee. In comparison, no samples were recorded above 20 for 2011/2012. The spike in reservoir-wide bird activity on February 10, 2012 of 1,903 birds and on February 24, 2012 of 1,905 birds compares to 2,006 birds observed on March 18, 2011 in the previous report (DEP 2011). The elevated bird counts did not appear to have an important influence on fecal coliforms levels as the February 2012 bacteria counts for EARCM remained in the single digits.

DEP conducted reproductive control on Canada Geese from April 1 through June 30, 2011 to reduce productivity at Ashokan. In 2011, three Canada Goose nests were identified and four eggs addled compared to 4 nests and 19 eggs 2010 (Table 4). The egg-depredation success rate at the Ashokan Reservoir in 2011 was 21 percent compared to a 37 percent success in 2010. A total of 15 goslings were observed in late spring 2011 the same number as in spring 2010, some of which are known to have hatched in wetlands off DEP property. There were no Mute Swans found nesting in 2011 similar to 2010.

5. Croton Falls Reservoir

The 2007 FAD lists Croton Falls Reservoir as one of five reservoirs covered under the "as needed" criteria for Waterfowl Management. The Croton Falls Reservoir is divided into five bird sampling geographic zones associated with reservoir water quality sampling locations (Figure 42). Similar to the previous year gulls and waterfowl (ducks) continue to represent the primary bird groups counted throughout Croton Falls Reservoir from the late July 2011 through the spring of 2012 however due to the mild winter only 50 percent of the reservoir froze. The lack of reservoir ice-cover likely allowed the waterbirds continual winter roosting opportunities unlike the previous year when extensive ice-cover occurred (Figures 26 and 27).

Geese were present throughout the year unlike previous spiking at 62 on July 15, 2011. Waterbird species (mostly Common Mergansers, *Mergus merganser* and Mallards, *Anas platyrhynchos*) were present throughout the year; increasing in numbers in late July resulting two spikes at 660 on December 2, 2011 and again on March 9, 2012 at 912 similar to the roosting pattern 2010/2011 (Figures 25 and 26). The increase in gull activity started in late July 2011 and maintained a continual winter roost up to the late winter with the onset of spring migration peaking at 1,564 on February 10, 2012. In the previous report, gull counts spiked at 900 on December 17, 2010 then dropping to zero during ice cover from late December though late February 2011 (DEP 2011).

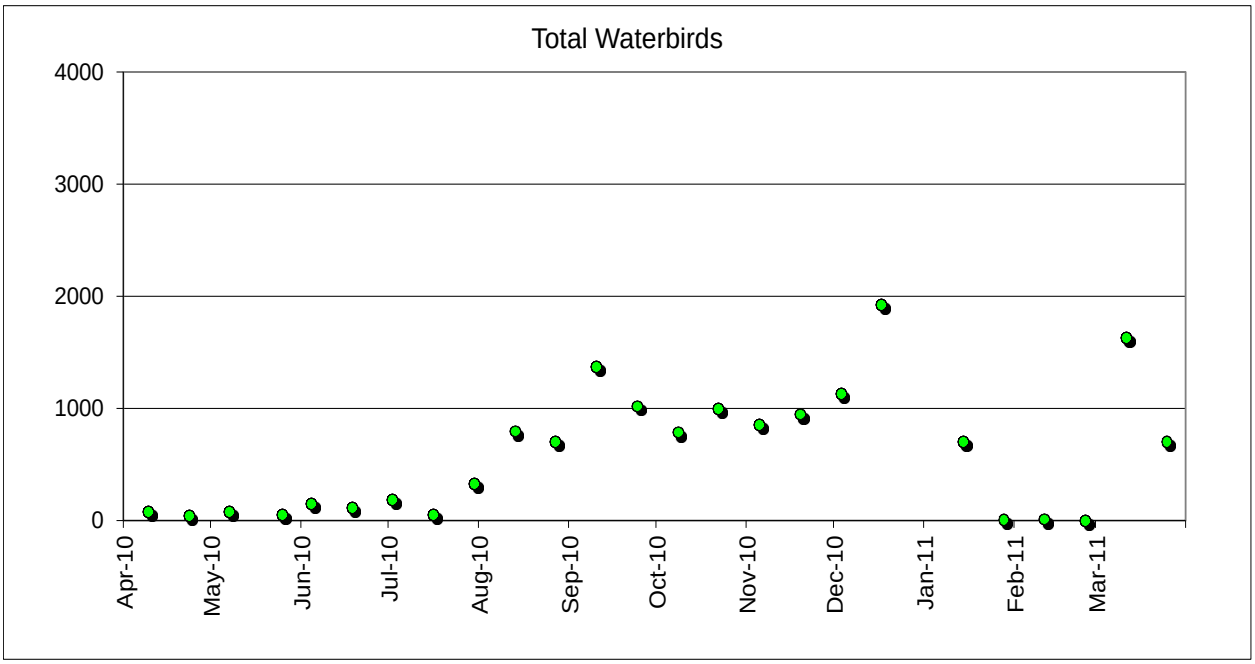

Figure 25. Croton Falls Reservoir total waterbirds - (4/1/2010 to 3/31/2011).

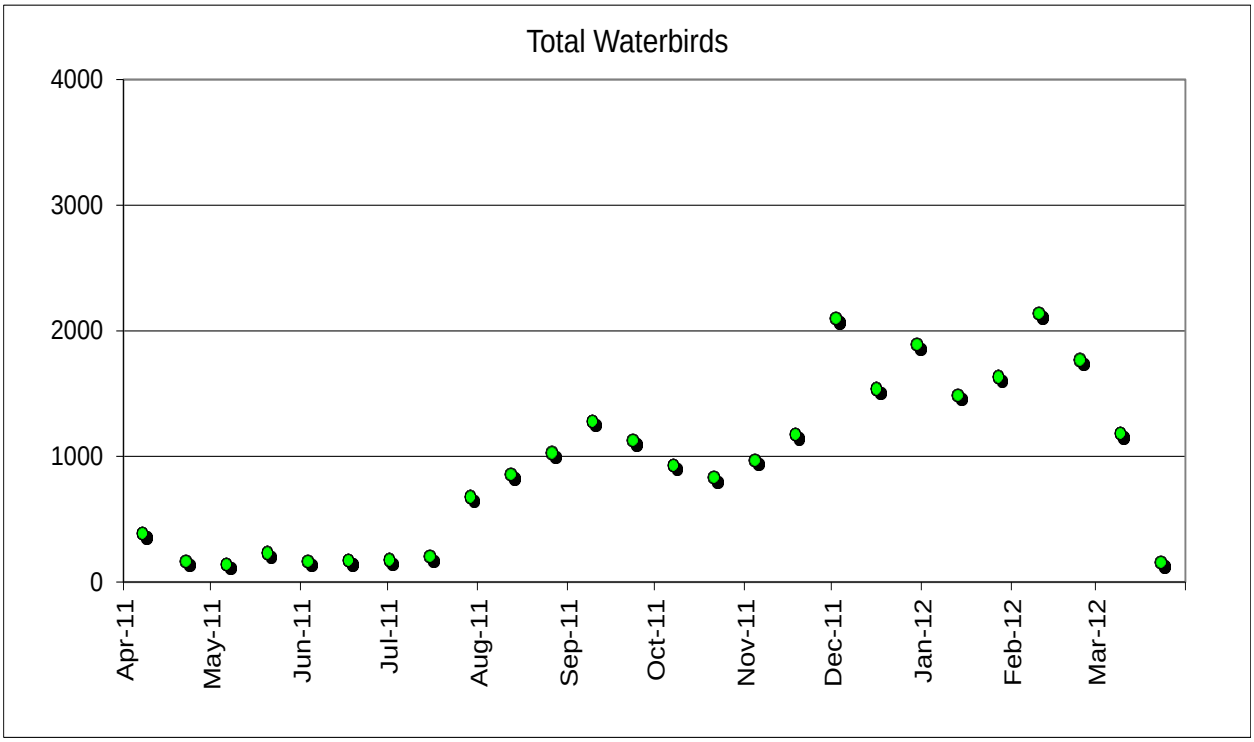

Figure 26. Croton Falls Reservoir total waterbirds (4/1/2011 to 3/31/2012).

There were a total of nine double-digit fecal coliform bacteria samples measured at the Croton Falls release in 2010/2011, four of which were above 20 fecal coliforms $100mL^{-1}$. A spike of 1,634 in total birds occurred on March 11, 2011 with a corresponding fecal coliform level of 27 fecal coliforms $100mL^{-1}$. While there does appear to be a relationship between the seasonal increases in bird activity and elevated fecal coliform bacteria levels (Figure 27), the Croton Falls Pump Station was not operated in 2011. As such, activation of the "as needed" waterbird dispersal program was unnecessary during this reporting period.

DEP conducted reproductive control on Canada Geese from April 1 through June 30, 2011 to reduce productivity at Croton Falls (Table 4). In 2011, 12 Canada Goose nests were identified and 55 eggs were depredated compared to six nests and 24 eggs 2010 (Table 4). The egg-depredation success rate at Croton Falls for 2011 was 95 percent with three goslings that hatched. There were no Mute Swans found nesting in 2011 similar to 2010.

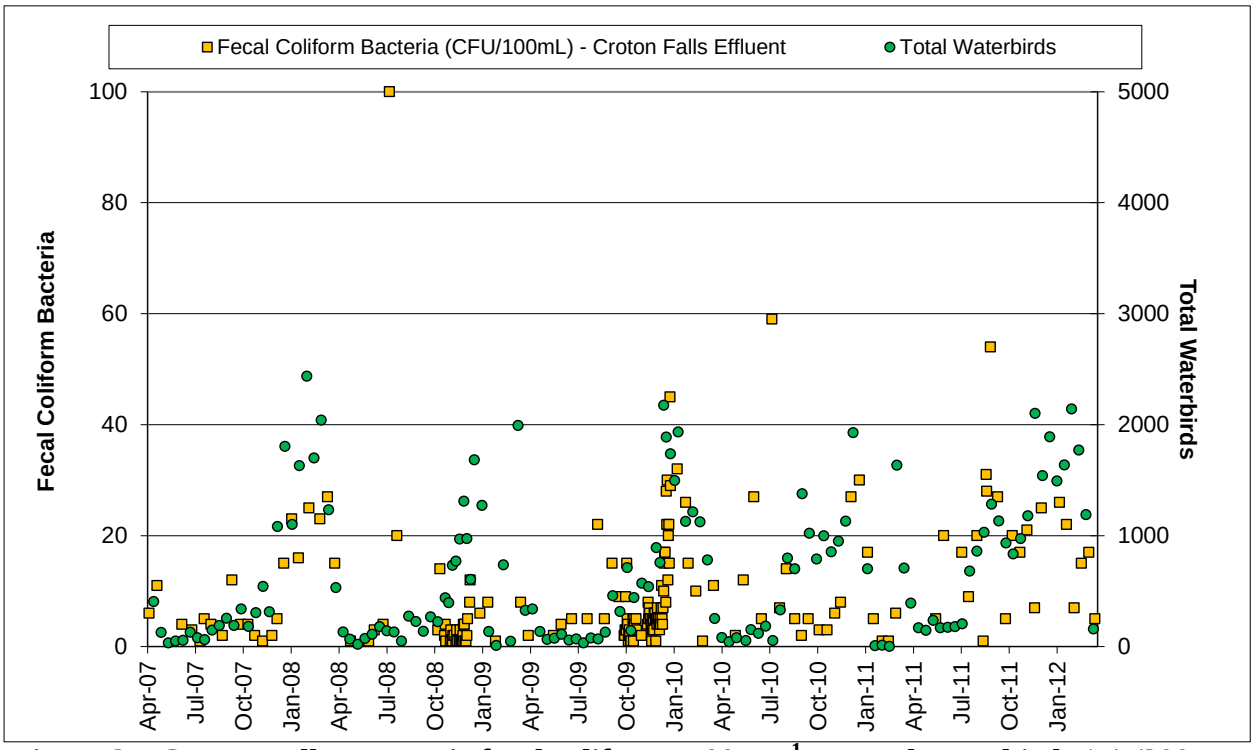

Figure 27. Croton Falls Reservoir fecal coliforms $100mL^{-1}$ vs. total waterbirds (4/1/2007 to 3/31/2012).

6. Cross River Reservoir

The 2007 FAD lists Cross River Reservoir as one of five reservoirs covered under the "as needed" criteria for Waterfowl Management. The Cross River Reservoir is divided into three bird sampling geographic zones associated with reservoir water quality sampling locations

(Figure 43). Bird numbers at Cross River were similar with those reported in previous years peaking at 932 recorded on January 20, 2012 compared to a high of 489 recorded in November 24, 2010 (Figure 28). Canada Geese numbers reached a high count of 384 on January 20, 2012 probably due to the lack of ice cover during the winter period. The reservoir reached a maximum ice cover of approximately 50 percent on January 19, 2012. The duck population rose from early September through early January 2011, until the reservoir iced-over. Waterbirds continued to roost on the reservoir throughout the entire winter unlike previous years when almost no birds were present from the onset of reservoir-wide ice cover. Gulls were only observed on three surveys at Cross River with a high count of 20 on April 1, 2011 compared to a high of 56 observed on March 18, 2011 (DEP 2011).

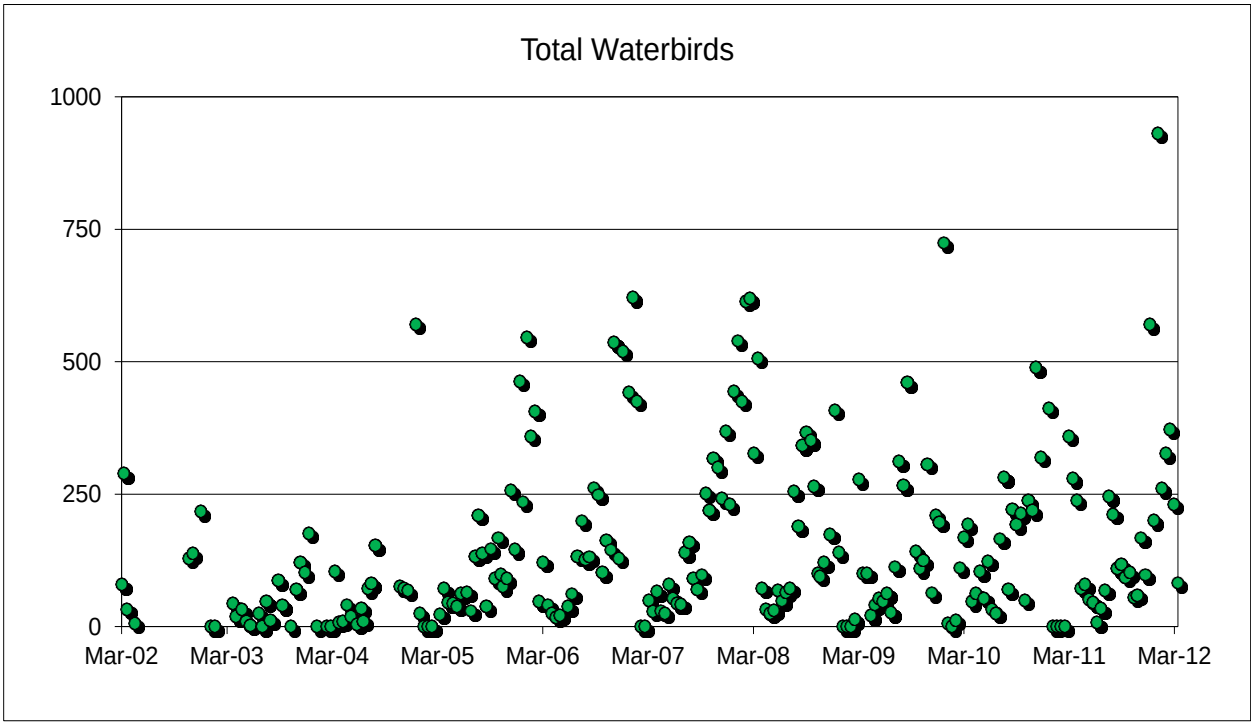

Figure 28. Cross River Reservoir total waterbirds (3/22/2002 to 3/31/2012).

Fecal coliform bacteria concentrations identified in water samples at Cross River Reservoir exceeded the 20 fecal coliforms $100mL^{-1}$ level seven times compared to four times in the previous reporting period (Figure 29). The bacterial elevations at the Cross River Effluent Chamber do not appear to be coincidental with population surges of waterbirds although biweekly sampling may not capture daily or temporary migratory increases. The Cross River Pump Station was not utilized during this reporting period, and activation of the "as needed" waterbird dispersal program was unnecessary.

DEP conducted reproductive control on Canada Geese from April 1 through May 31, 2011 to

reduce productivity at Cross River. In 2011, 12 nests were identified and 32 eggs addled compared to seven nests and 33 eggs 2010 (Table 4). The egg-depredation success rate for Cross River in 2011 was 100 percent. There were no Mute Swans nesting in 2011.

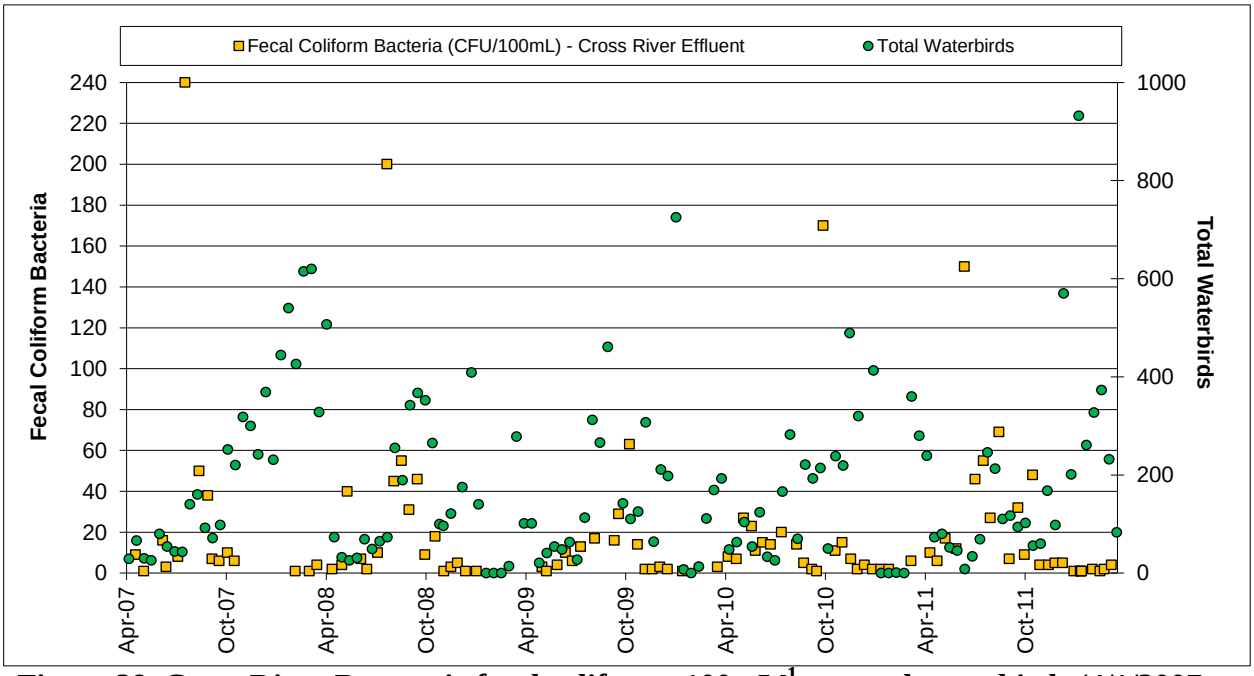

Figure 29. Cross River Reservoir fecal coliforms 100mL^{-1} vs. total waterbirds (4/1/2007 to 3/31/2012).

7. Hillview Reservoir

The City's Long-Term Watershed Protection Program (July 2007 FAD) expanded the Waterfowl Management Program to include Hillview Reservoir on an "as needed" basis similar to the 2002 FAD expansion for five additional reservoirs listed above. DEP initiated an in-depth program starting in 1993 which continues through the present day. The Hillview Reservoir is divided into two bird sampling geographic zones associated with the reservoirs two distinct basins and water quality sampling stations (Figures 44 and 45). Waterbird population survey frequencies have varied through the years but generally have been conducted at a minimum on a weekly basis and most often on a daily basis. Bird deterrent and harassment activities have also been employed since 1993 with a high level of success reducing and in most cases eliminating the presence of roosting waterbirds, particularly geese, cormorants, and gulls.

Prior to 1993, DEP Operations staff infrequently employed a variety of noisemakers to eliminate birds roosting diurnally and nocturnally at Hillview. During the summer of 1993, DEP's Wildlife Studies Section initiated a formal bird management program to monitor birds throughout the year and develop a bird deterrence/harassment program. Pyrotechnics and

propane operated cannons were initially used to chase the birds off the water and adjacent shaft buildings. In July 1994, a bird deterrent wire system was partially installed which formed an aerial grid above the surface water to prevent birds such as swans, cormorants, geese, gulls and ducks from landing and defecating in the water. The wire grid, which was mostly completed by the spring of 1995, consisted of a combination of high-test monofilament, Kevlar wire, and twine. The grid was strung along the shoreline fences spanning a distance of nearly 1,200 feet. From 1994 to 2006, this wire grid system was maintained by DEP staff until a contract was let in 2006 to install an upgraded version of the wire deterrent system using 15' stanchions with reel tensioning devices at the base. DEP and its contractor continue to use pyrotechnics, propane cannons and employ physical chasing techniques to supplement the wire system to actively keep birds off the reservoir. In the early winter of 2008, DEP installed remote-operated propane cannons along the reservoir's dividing wall to keep gulls and other birds from roosting on the dividing wall railings. The cannons were supplemented by installation of Daddi-Long-Legs (bird deterrent wires) placed on the tops of the 15' stanchions to prevent birds from roosting. The program enhancements were funded in association with an EPA Administrative Order.

An EPA Administrative Order on Consent governing the covering of Hillview Reservoir (Docket No. SDWA-02-2010-8027 Catskill Delaware System) was signed on May 24, 2010. Under this order and beginning on August 1, 2011 DEP started implementing an enhanced wildlife management program at Hillview to further protect the water supply. New best management practices included increased bird census conducted on a daily from pre-dawn to post-dusk hours and harassment from 8:00am until dusk; mammal population monitoring and removal; alewife (baitfish) monitoring and removal, animal sanitation inspections (facility and grounds inspections and clean-up of animal feces); swallow spp. management; and continued monthly reporting on wildlife management activities at Hillview Reservoir.

Overnight waterbird counts have been conducted since 1993 whereas daytime counts were initiated in the summer of 2004 with less frequent data collected from 1993 through 2004 (Figures 30 and 31). During the period from summer 2004 through early 2007 the overhead bird deterrent wire system was in disrepair and in preparation for replacement. Prior to bird wire mitigation in 1994, gulls comprised more than 70 percent of the night-roosting species on the reservoir. This compares to 1.0 percent for gulls, 0.1 percent for geese, and 98.8 percent for ducks in this reporting period compared to 98.9 percent in 2010/2011. Except for a low number of diving ducks (Ruddy Ducks, *Oxyura jamaicensis*) all waterbirds observed and reported on both nocturnal and diurnal surveys were harassed off the reservoir using pyrotechnics, cannons, and physical chasing from 8:00am until post-dusk times. DEP contractor crews were largely successful in dispersing the gulls and geese once observed. The ducks have generally remained unaffected by a variety of bird deterrent and harassment measures employed by DEP to date. As a result, DEP utilized contract services with USDA for lethal removal of ducks during this reporting period. The lethal duck removal program was initiated in April 2011 and was conducted on an as needed basis. A total of 14 Ruddy Ducks were lethally removed during this reporting period by sharpshooters stationed along the reservoir shoreline.

Overnight and daytime waterbird counts on both basins remained very low and almost exclusively from a relatively small resident duck population. Of the 364 overnight surveys conducted there were only 14 instances of small numbers of gulls observed during the overnight period. For nine of the 14 gull nights' only one gull was observed roosting and the high overnight count of 14 gulls was recorded on September 13, 2011. There was only one observation of five Canada Geese recorded during the overnight observation on June 21, 2011 prior to immediate removal. An unusually large group of 100 Canada Geese was observed during the early morning hours on December 5, 2011 in heavy fog conditions (Figure 31). The geese were immediately removed with the use of pyrotechnics. Overnight waterbird counts peaked at 36 on November 25, 2011 compared to a high of 104 in the previous report (DEP 2011). Water quality results for Hillview are presented as number of positive *E. coli* for each month of the reporting period at four water quality sampling locations (Figures 32-35). Bird counts were generally lowest during the *E.coli* detections recorded at Sampling Site 3 from June through early September 2011. There were no positive E.coli detections recorded at Sampling Sites 1, 2, and 58.

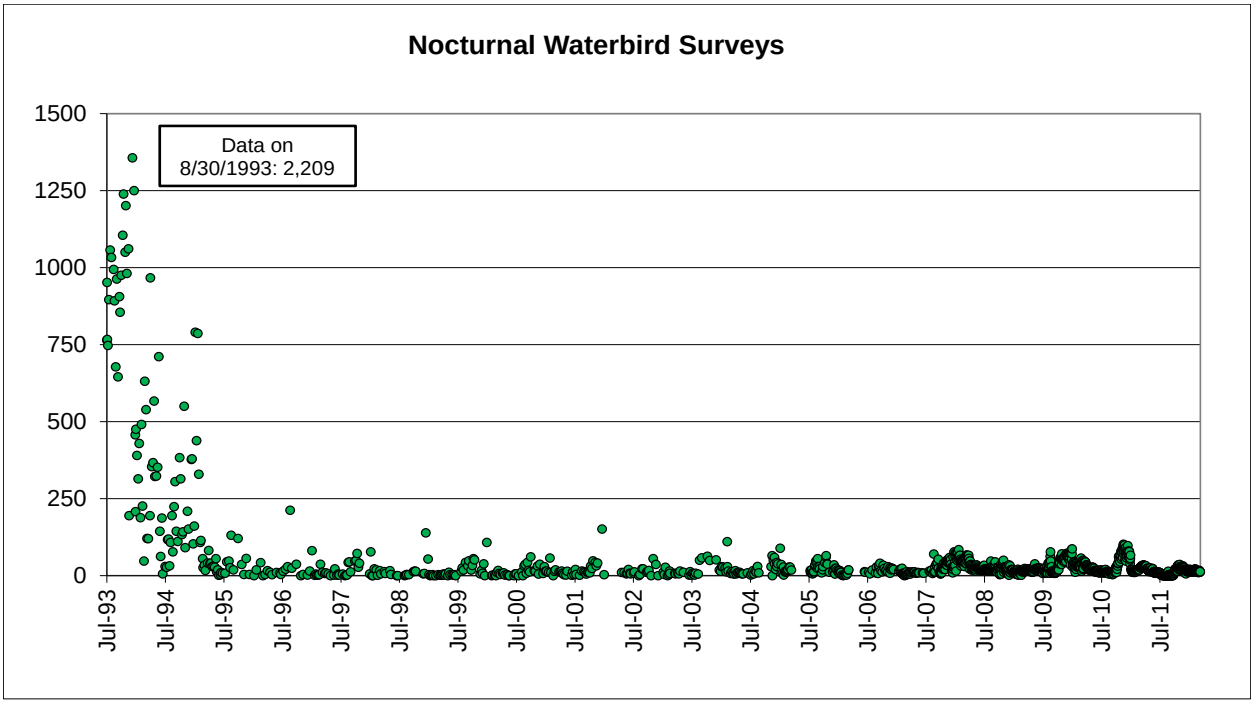

Figure 30. Hillview Reservoir total waterbirds nocturnal counts (1993 to 2012).

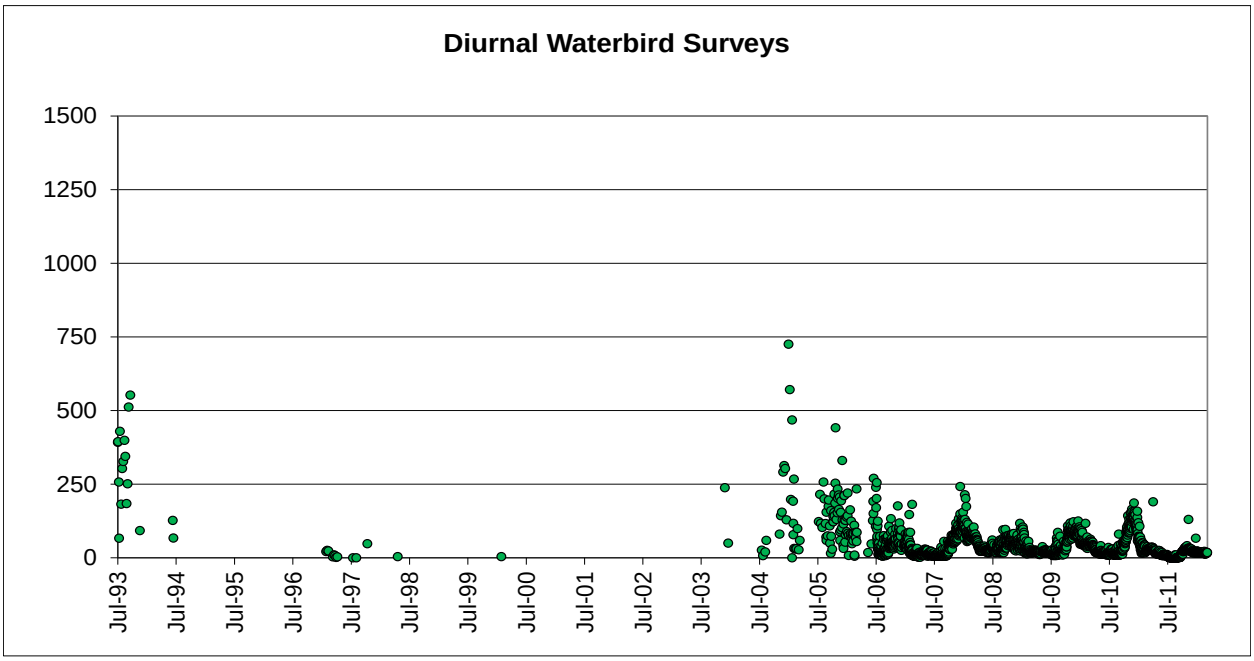

Figure 31. Hillview Reservoir total waterbirds diurnal counts (1993 to 2012).

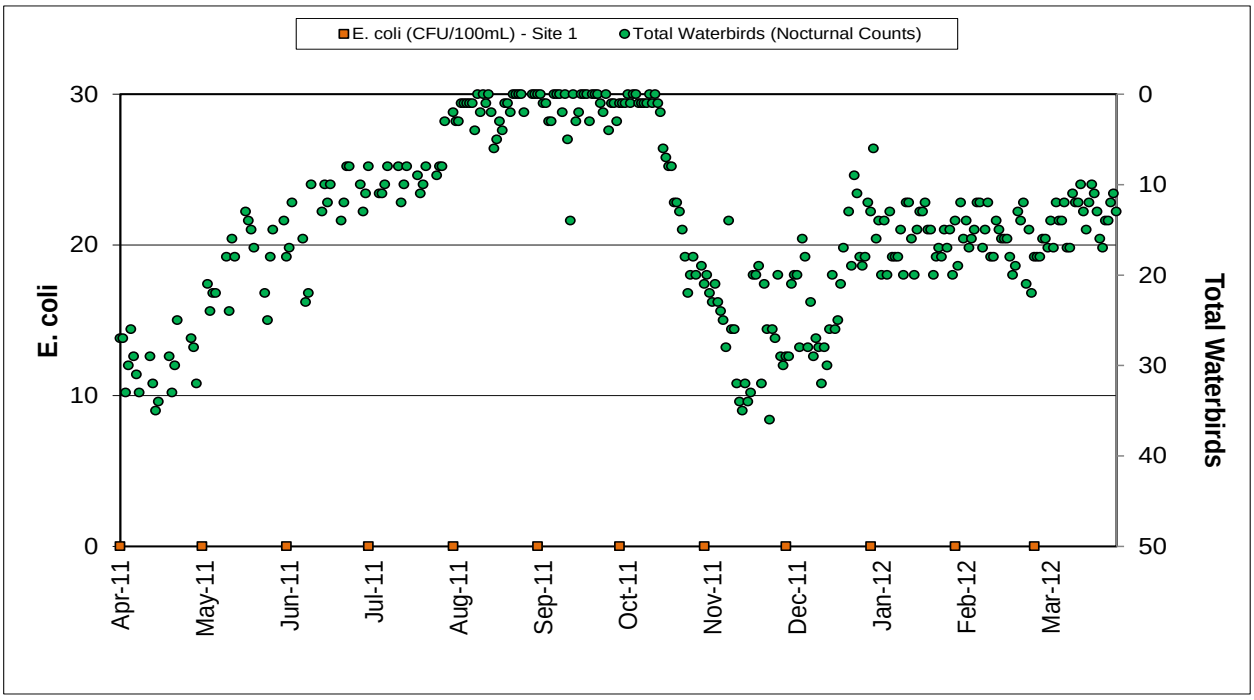

Figure 32. Hillview Reservoir number of positive E. coli at water Sampling Site 1 versus total waterbirds (4/1/2011 to 3/31/2012).

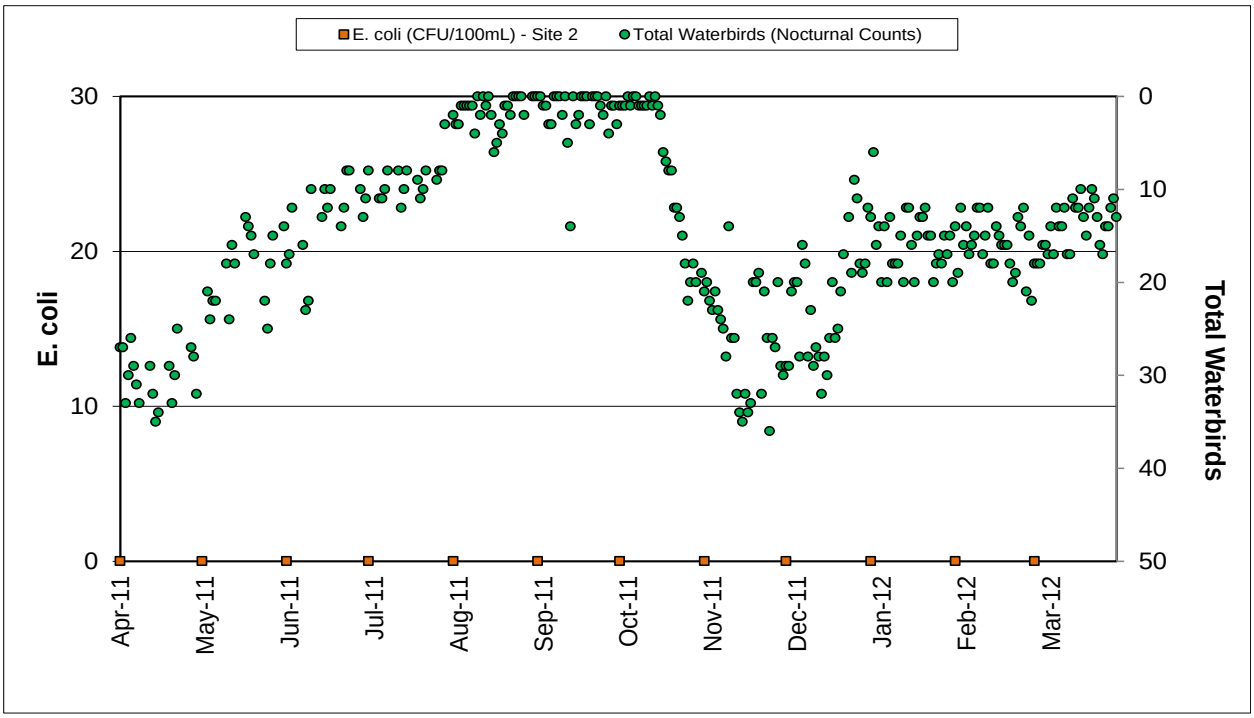

Figure 33. Hillview Reservoir number of positive *E. coli* at water Sampling Site 2 (4/1/2011 to 3/31/2012).

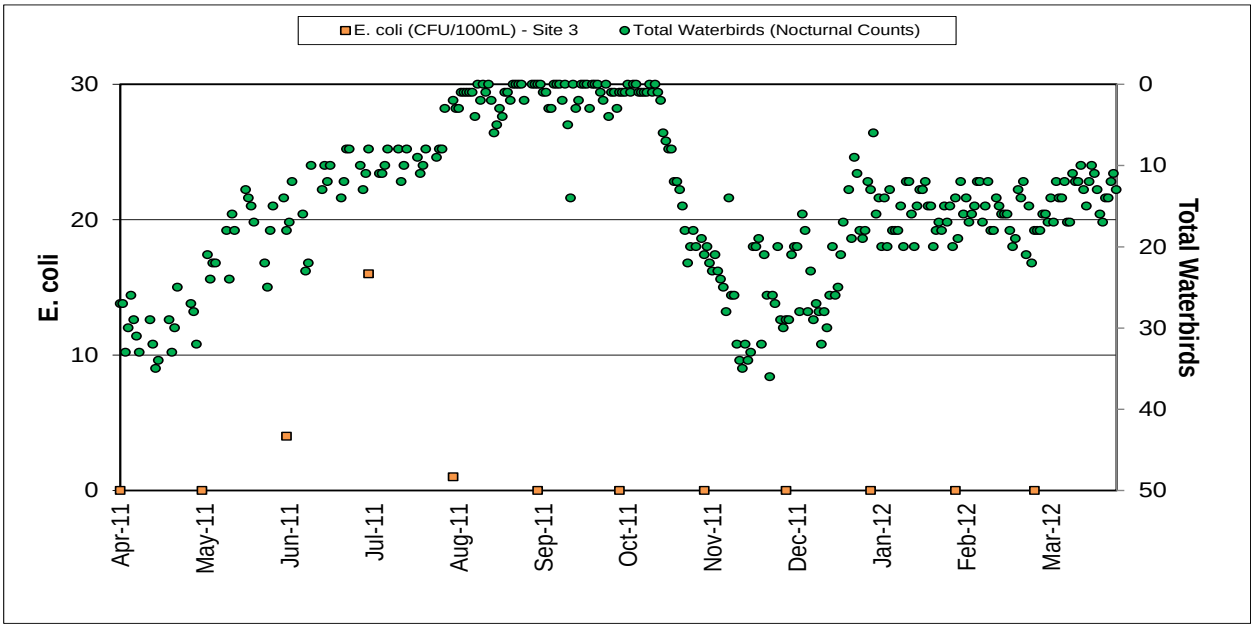

Figure 34. Hillview Reservoir number of positive *E. coli* at water Sampling Site 3 (4/1/2011 to 3/31/2012).

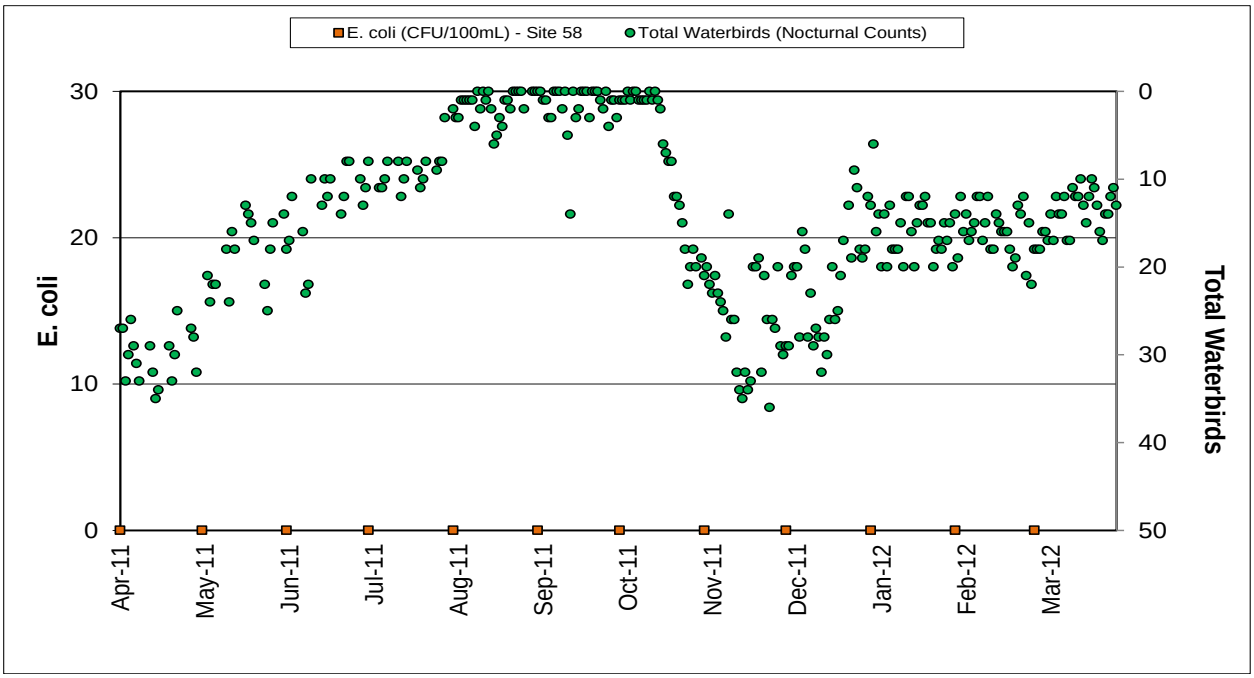

Figure 35. Hillview Reservoir number of positive *E. coli* at water Sampling Site 58 (4/1/2011 to 3/31/2012).

The behavior patterns of the waterbirds utilizing Hillview Reservoir are different from the other upstate reservoirs reported in the document as Hillview is situated in a highly urbanized area and surrounded by large populations of breeding gulls throughout the NYC metropolitan area. This partially explains why gull activity is a year-around challenge at Hillview. Since the installation of the bird deterrent wire system in 1994, small numbers of gulls and two species of ducks remain the target of active harassment activity.

DEP first attempted to trap and relocate the small flock of Ruddy Ducks in December 2008 and continues this effort using, nets, running remote control motor boats, harassment, and attempted capture by boat. Success was limited to the capture and removal of one Ruddy Duck by net. A total of 18 Ruddy Ducks were removed from June 9, 2011 to March 14, 2012 through contract services with USDA. Five Ruddy Ducks perished at Hillview during this reporting period. Twenty-two of 23 specimens collected and submitted to DEC Wildlife Pathology Unit for stomach content analysis and cause of death during this reporting period are pending necropsy Case Reports. Since Ruddy Ducks are not typically found as breeding species in this region, it is believed that the resident ducks with deformities perished due to dietary changes. Since 2008, 12 specimens appear to have been affected by drowning due to starvation or starvation/trauma and stomach contents were generally empty with the carcasses in poor flesh (DEC Case Reports 2010). The Hillview basins are concrete and may not provide proper nutrition of aquatic invertebrates for the ducks to survive. Additional actions employed by DEP working in

conjunction with assistance of DEC and USDA Wildlife Services included the following:

- September 2008 and February 2009 – Present: Use of remote control motor boat for harassment.
- December 2008 – Present: Use of canoes, kayaks, and electric motored Jon-boats for harassment.
- September 2009 – Present: Deployment of gill nets and use of electric motored Jon-boats to attempt to capture ducks.
- April 2010 – Experimental lethal shooting employed by the USDA Wildlife Services.
- April 2010 – Present: Nighttime spotlighting using electric motored Jon-boats for capturing ducks.
- July 2010 – Present: Bird wiring installed on reservoir shaft buildings intake openings to preclude roosting and breeding swallow spp.
- January 2011 – Submission of a monthly report on wildlife management activities to DOH and EPA.
- June 2011 – Present: USDA Wildlife Services Contract implemented to remove all resident ducks or other waterfowl that are unsuccessfully harassed by other non-lethal means as needed.
- August 2011 – Present: Under the Administrative Order and enhanced wildlife management program was implemented and includes the following:
    - Increased weekly survey shifts from 10 per week to 14 per week to allow daily, dawn to dusk coverage.
    - Started daily sanitation surveys on August 1, 2011 – observations and removal of animal fecal matter on the reservoir shaft buildings on the reservoir dividing wall.
    - Started weekly small mammal trapping inside the reservoir perimeter fence and on the dividing wall on August 1, 2011.
    - Started removals of Barn and Cliff Swallow nests and Osprey nests on the reservoir shaft buildings and along the dividing wall bird wire stanchions outside the established nesting seasons. Activity began in autumn of 2011 and continued through early spring of 2012.
    - Started collection and disposal of alewives (baitfish) from the Uptake 1 facility (water received from Kensico Reservoir). Removal of alewives facilitates the elimination of waterbird foraging activity and roosting at the reservoir.

DEP will continue to assess the feasibility of trapping efforts using the nighttime spotlighting technique as well as gill net deployment in the late summer when the ducks undergo a molt and are temporarily rendered flightless. If live-trapping efforts are successful the small flock of Ruddy Ducks will be relocated to a northern New York location that has been predetermined by the DEC. Daily monitoring and bird harassment activities will continue under a DEP contract to supplement the new bird wire grid system which was completed in late 2007.

CONCLUSION

DEP's Waterfowl Management Program is a key component to the City's continuance of Filtration Avoidance as outlined under the 2007 Filtration Avoidance Determination. The program has helped DEP in maximizing flexibility in choosing the highest quality water for distribution. The Waterfowl Management Program has been in continuous operation since 1993 and continues to effectively reduce waterbird populations and keep fecal coliform bacteria levels in compliance with the Environmental Protection Agency's Surface Water Treatment Rule (SWTR) of 1991 as part of the Safe Drinking Water Act regulations.

It is well established that waterbird elevations and their spatial distributions relative to water intake facilities on NYC watershed reservoirs can affect fecal coliform bacteria levels in water samples collected. Therefore, DEP will continue with year-around monitoring and bird reduction measures where necessary.

The reduced waterbird and fecal coliform bacteria counts at Kensico Reservoir, Hillview Reservoir, and other reservoirs covered under the "as needed" section can be attributed directly to the variety of bird dispersal and deterrence techniques. When dispersal tools (motorboats, airboats, propane cannons, and pyrotechnics) are used in a variety of combinations they result in the most effective means to bird reduction over large open areas of drinking water. To date, it remains inconclusive what the tolerable number of waterbirds is at NYC reservoirs before water quality is compromised; therefore, the objective of the Waterfowl Management Program will be to continue with the elimination of all roosting birds during the bird migratory seasons for Kensico and Hillview Reservoirs and on an "as needed" basis for reservoirs that are a direct source to Kensico.

The establishment of bird-free zones (spatial distributions) around water intake structures at reservoirs that are sources to Kensico (i.e., West Branch, Rondout, and Ashokan Reservoirs), whether program-initiated through harassment or by the natural process of the birds selecting roosting locations, continues to be a key influence on lower fecal coliform bacteria levels. The spatial distributions of the birds in relation to the flow dynamics of the reservoir appear to have the greatest influence in the transport of bacteria to the water intakes. It is evident that when DEP properly manages its waterbird populations, bird-related fecal coliform bacteria concentrations remain low and in compliance with EPA regulations.

Bird deterrence measures which include waterbird reproductive management, bird deterrent netting, overhead bird deterrent wires, shoreline fencing, and meadow management continued to reduce local breeding opportunities around water intake structures and eliminate fecundity during this reporting period. DEP will continue to consider options as deemed necessary for Canada Geese and Mute Swan management to reduce local breeding populations by means of "take" under federal and state depredation permits. The "take" option was employed by the USDA as part of the Westchester County Airport depredation order to remove local Canada Geese during this reporting period.

At the Hillview Reservoir, DEP continued to employ the use of pyrotechnics, physical chasing, remote-operated propane cannons, Daddi-Long-Legs, bird deterrent wires and netting, and lethal control measures to prevent ducks, gulls and other non-waterbird species from landing on the reservoir dividing wall. Remote-operated propane cannons have improved bird deterrence during times of inclement weather when contractor staff is not permitted on the reservoir dividing wall and pyrotechnics are rendered ineffective from the reservoir shoreline. As a part of the Administrative Order, DEP has initiated small mammal trapping inside the reservoir perimeter fence and on the reservoir dividing wall. In 2011/2012 a total of 11 raccoons and 7 mice were trapped and removed from the reservoir property. Under the current program, DEP is allowed under federal and state law to remove the swallow nests outside the active breeding period and did conduct such activity during this reporting period. DEP will consider applying for a federal depredation permit for 2012/2013 to remove active swallow nests during the nesting period at Hillview Reservoir if deemed necessary.

Waterbird populations continue to demonstrate seasonal elevations primarily during the autumn and winter periods in all reservoirs listed in this report. Climate alterations can affect behaviors and migratory activity changes of "local" or resident birds such as Canada Geese. Gull populations are migratory and utilize the New York City Reservoir system as a migratory stop-over or wintering area until local conditions (i.e. ice and snow cover) become too intolerable. Ice cover on the reservoirs and snow cover in the associated watershed or daily flight range for food often determine whether they will continue in migration. As a result, DEP will need to remain cognizant of these patterns and their potential impacts adjust their "as needed" program accordingly.

DEP continues to remain in compliance with SWTR regulations, with low seasonal elevations of fecal coliform bacteria were recorded annually from late autumn through early winter. While these elevations have at time been associated with migratory waterbirds stopping over and wintering on the reservoirs, during this reporting period they were mostly associated with major precipitation events (i.e. Tropical Storms Irene and Lee in 2011). Monitoring the effects that bird dispersal measures have on each reservoir has been achieved through routine population surveys and identifying bacteria origins. Survey results have provided inferences about the potential effects of avian fecal matter based on the spatial and temporal aspects of the birds and have also assisted DEP in evaluating the effectiveness of the dispersal measures. DEP will continue with the implementation of the Waterfowl Management Program as part of its Filtration Avoidance Program to ensure the highest quality water by managing waterbird populations.

REFERENCES

Alderisio, K.A. and N. DeLuca. 1999. Seasonal enumeration of fecal coliform bacteria from the feces of Ring-billed Gulls (*Larus delawarensis*) and Canada Geese (*Branta canadensis*), Applied and Environmental Microbiology 65:5628-5630.

EPA (U.S. Environmental Protection Agency). 1989. Drinking Water: National Primary Drinking Water Regulations; Filtration, Disinfection; Turbidity, Giardia lamblia, Viruses, Legionella, and Heterothrophic Bacteria; Final Rule. 54 Fed. Reg. 27486. June 29, 2989. WH-FRL-3607-7. Washington, D.C.

New York City Department of Environmental Protection (DEP). 1993. Kensico Watershed Study 1991-1993. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1994. Kensico Watershed Study Augmented Annual Research Report, January 1993- March 1994. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1995. Kensico Watershed Study Annual Research Report, April 1994-March 1995. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1996. Kensico Watershed Study Annual Research Report, April 1995-March 1996. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1997. Kensico Watershed Study Annual Research Report. April 1996-March 1997. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1997a. West Branch Drainage Basin Report, A Preliminary Data Review for Planning. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2002. Continue Implementation of Final Waterfowl Management Plan. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2003. Waterfowl Management Program. July 31, 2003. Division of Drinking Water Quality Control, Valhalla, NY

New York City Department of Environmental Protection (DEP). 2004. Waterfowl Management

Program. July 31, 2004. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2005. Waterfowl Management Program. July 31, 2005. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2006. Waterfowl Management Program. July 31, 2006. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2007. Waterfowl Management Program. July 31, 2007. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2008. Waterfowl Management Program. July 31, 2008. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2009. Waterfowl Management Program. July 31, 2009. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2010. Waterfowl Management Program. July 31, 2010. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2011. Waterfowl Management Program. July 31, 2011. Division of Drinking Water Quality Control, Valhalla, NY.

New York State Department of Environmental Conservation (DEC). 2010. Case Reports. June 8, 2010. Wildlife Pathology Unit, Delmar, NY.

New York State Department of Environmental Conservation (DEC). 2010. Case Reports. June 9, 2010. Wildlife Pathology Unit, Delmar, NY.

Appendix A. Reservoir maps with bird zone designations and water sampling locations

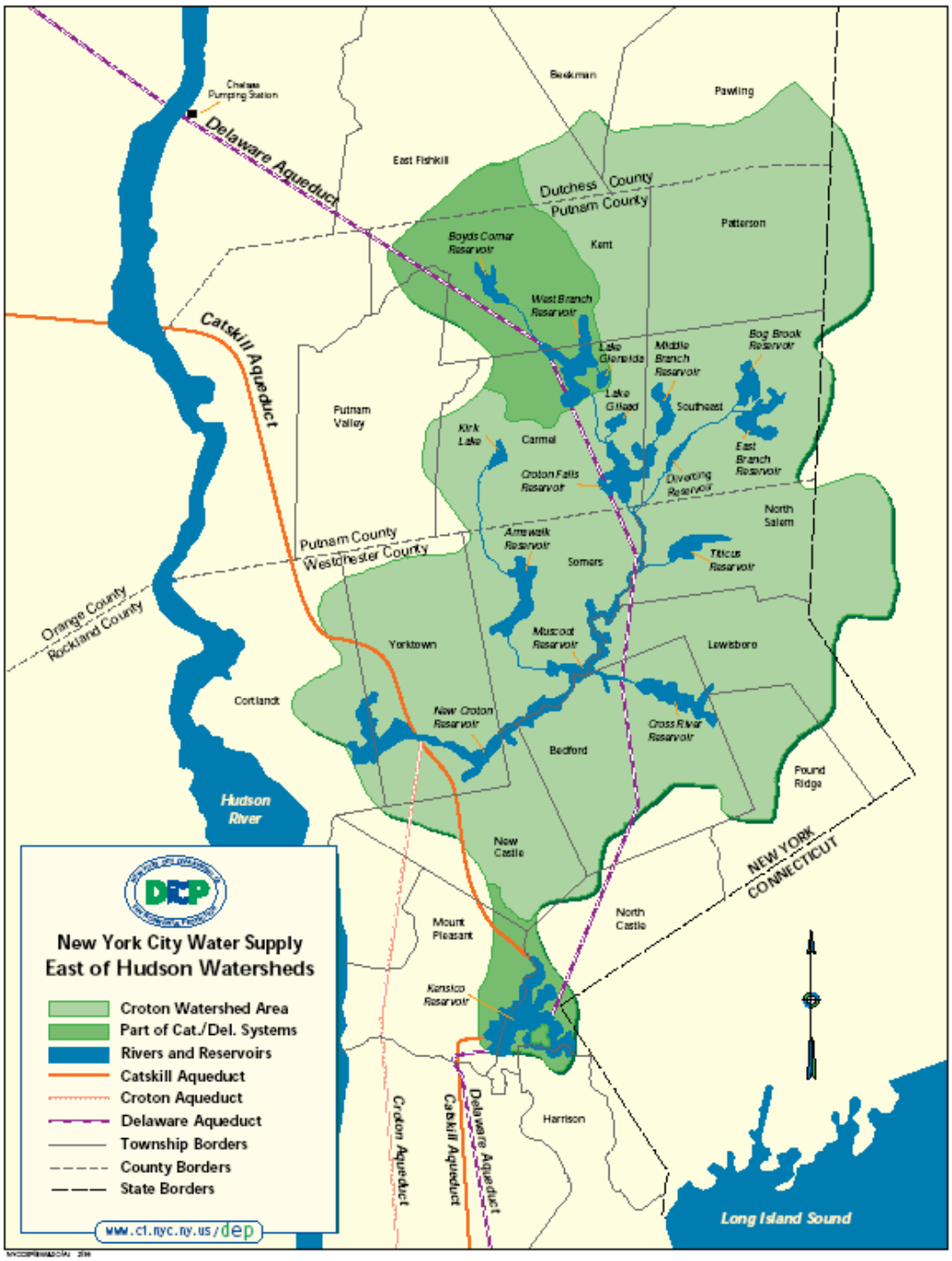

Figure 36. Map of New York City Water Supply System – East of Hudson Region.

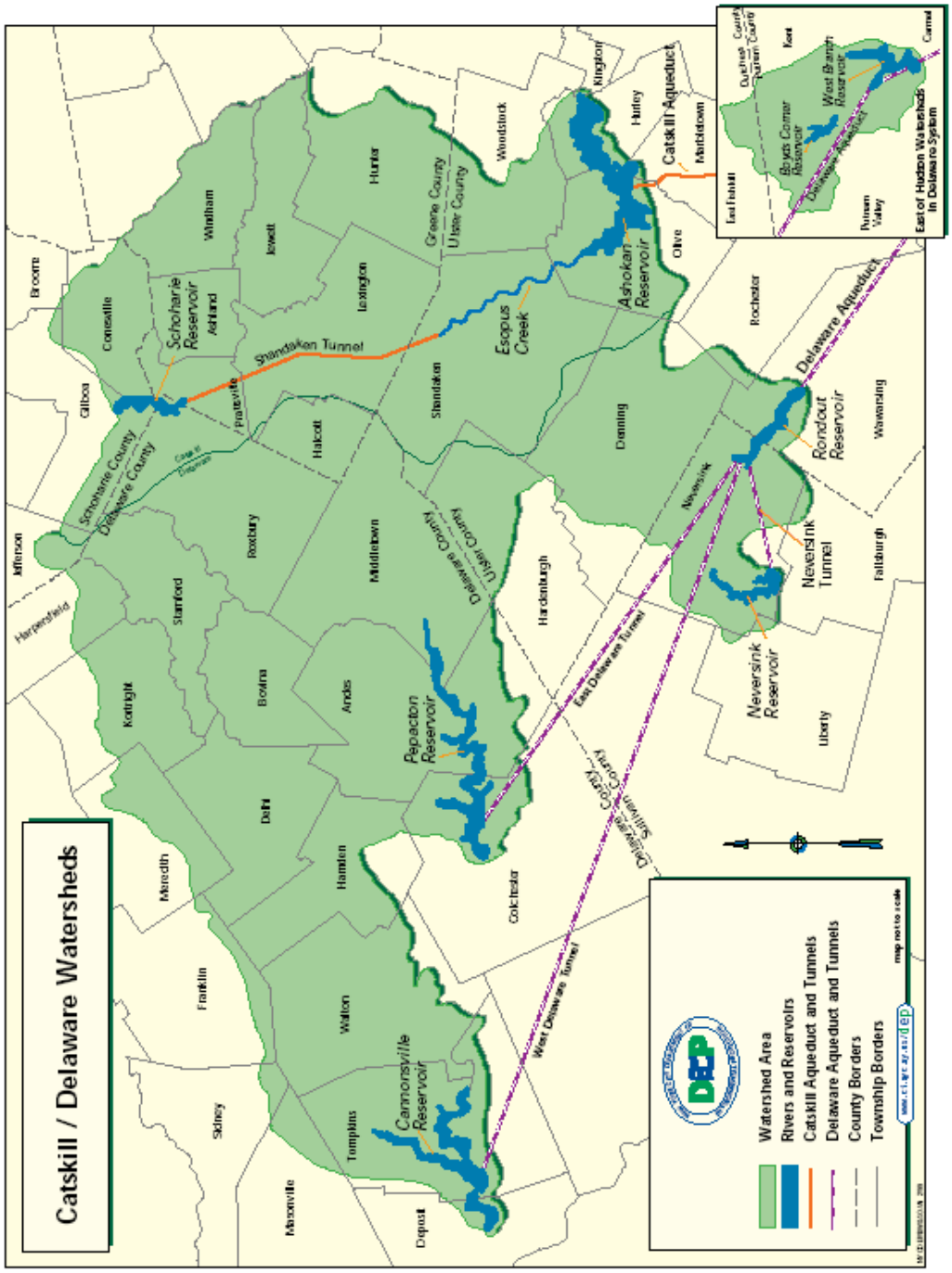

Figure 37. Map of New York City Water Supply – West of Hudson Region.

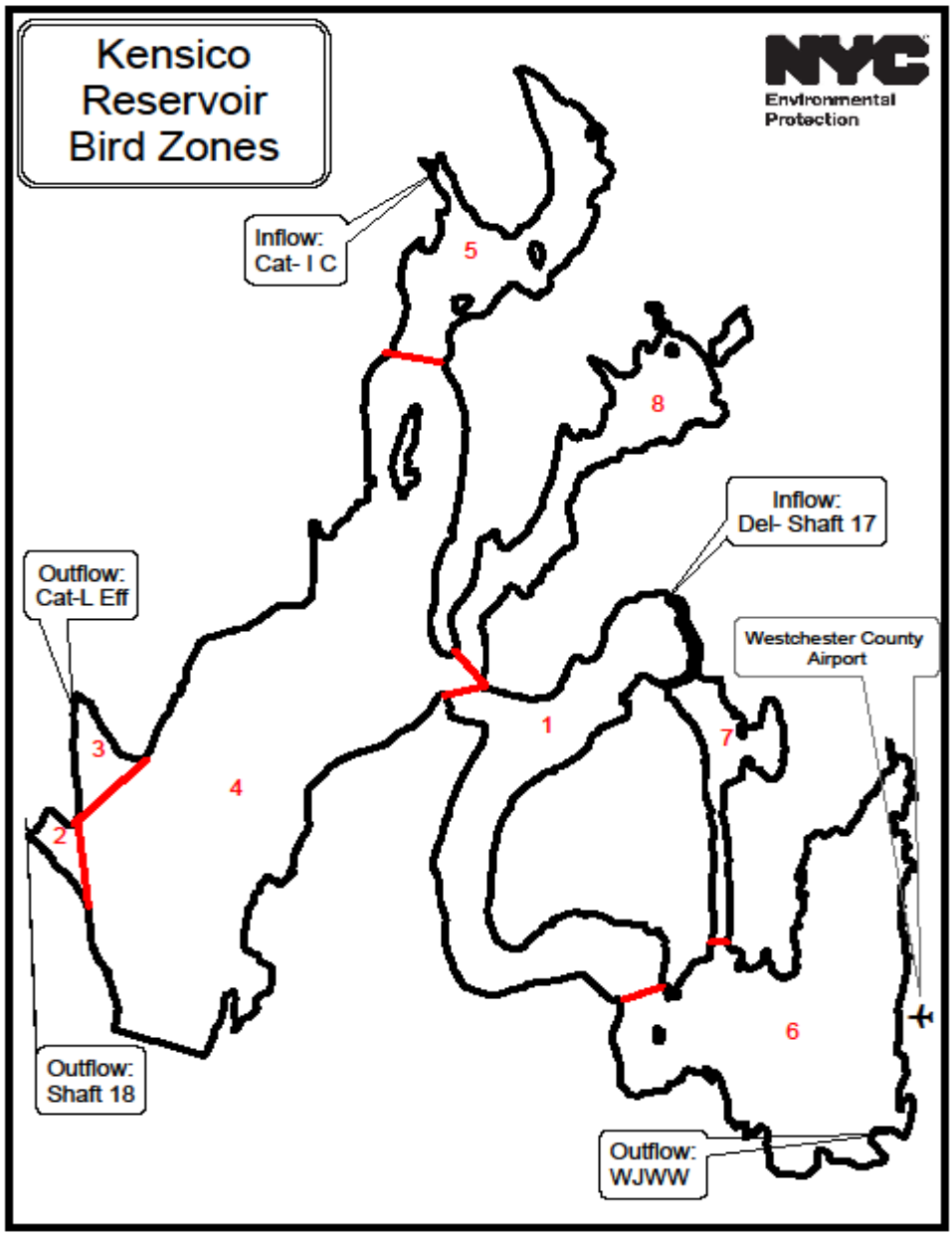

Figure 38. Map of Kensico Reservoir bird zones.

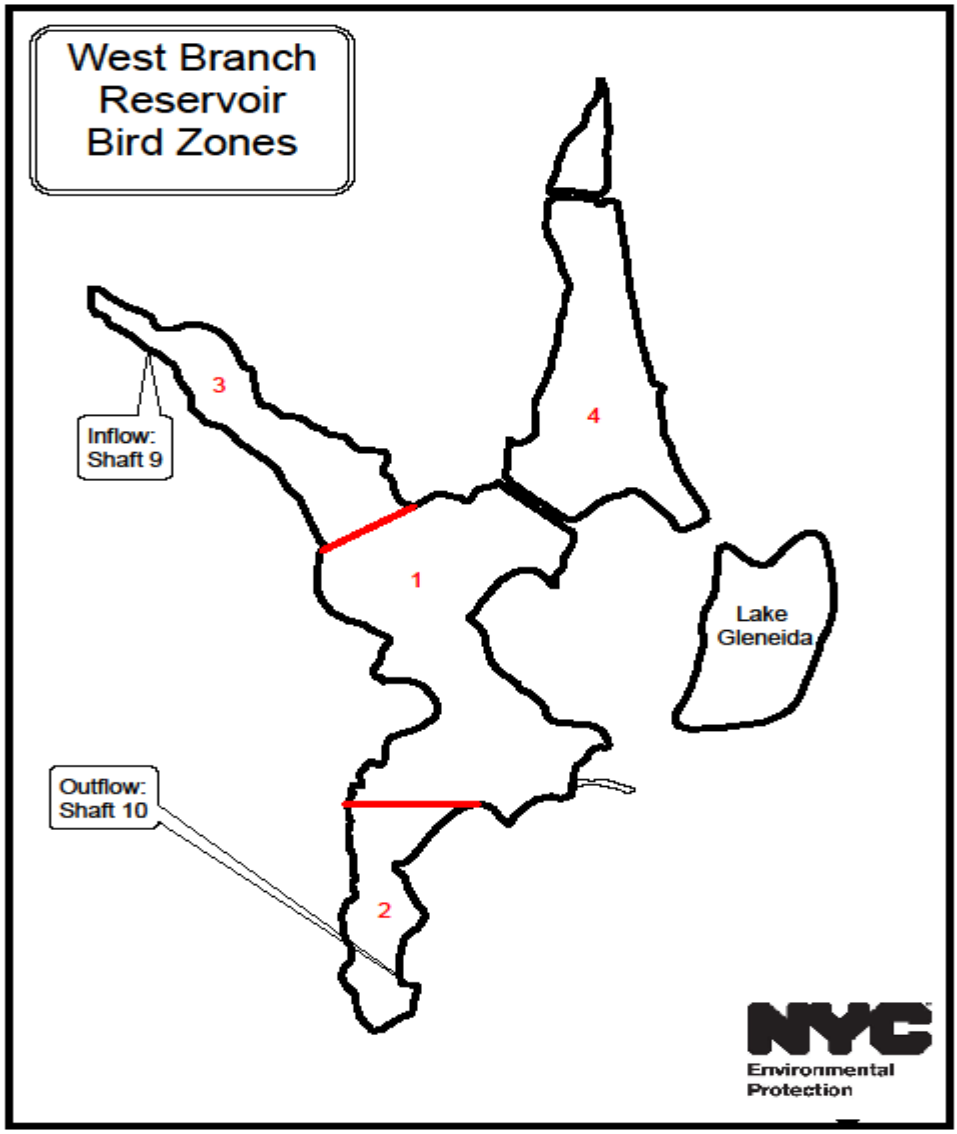

Figure 39. Map of West Branch Reservoir bird zones.

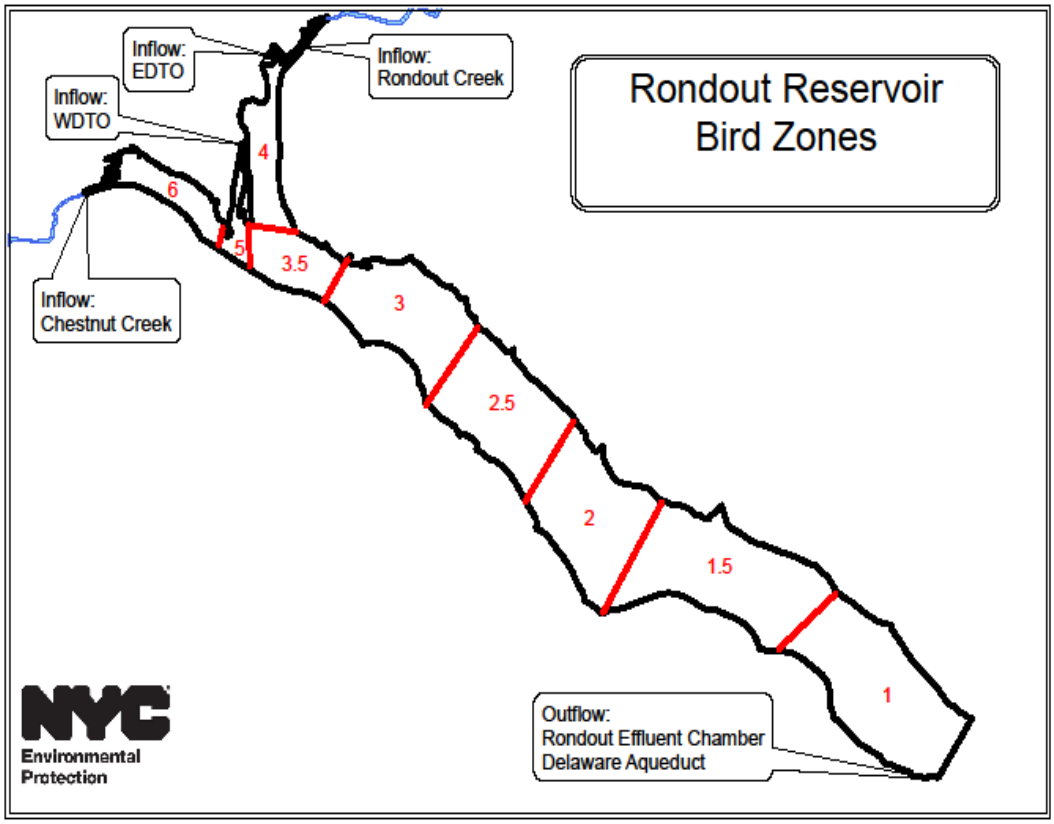

Figure 40. Map of Rondout Reservoir bird zones.

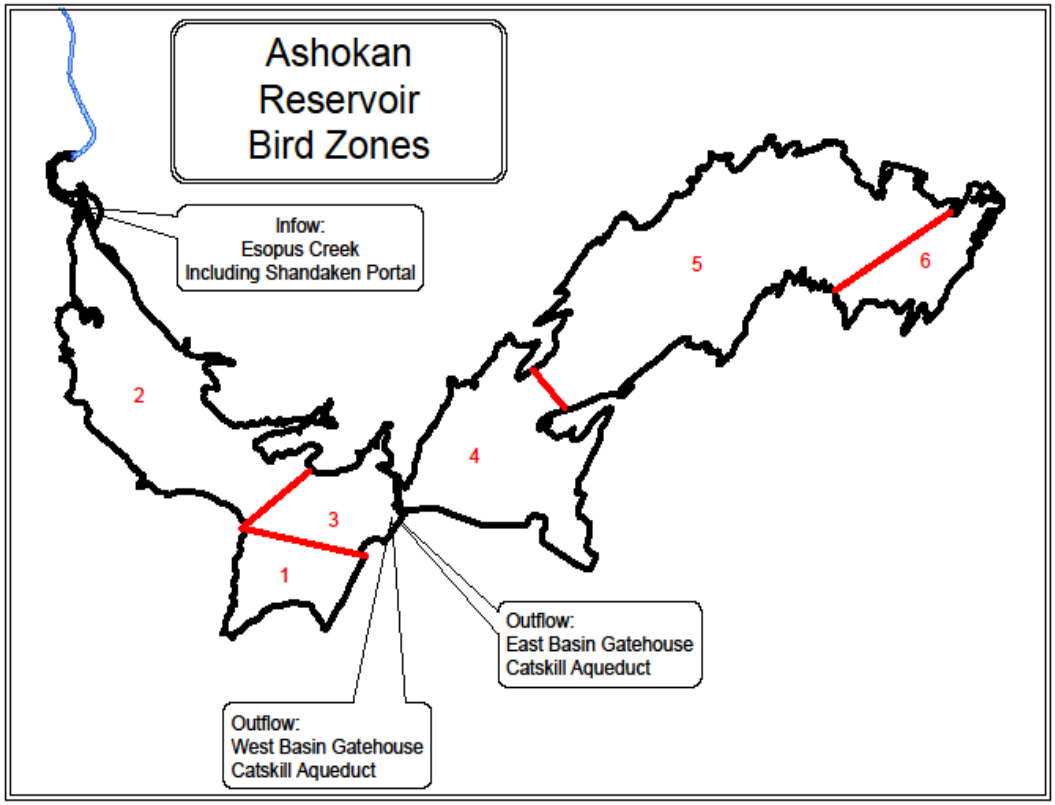

Figure 41. Map of Ashokan Reservoir bird zones.

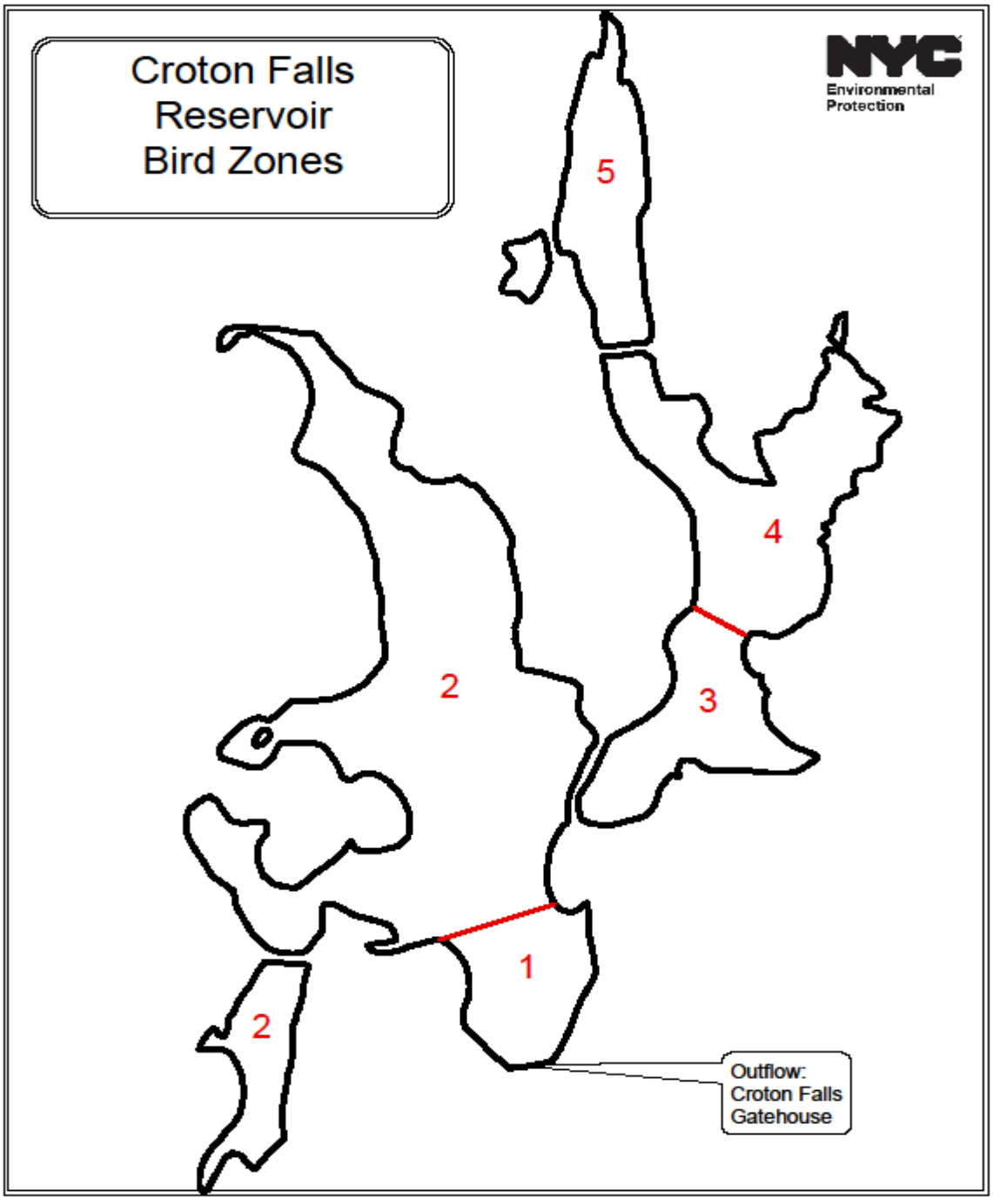

Figure 42. Map of Croton Falls Reservoir bird zones.

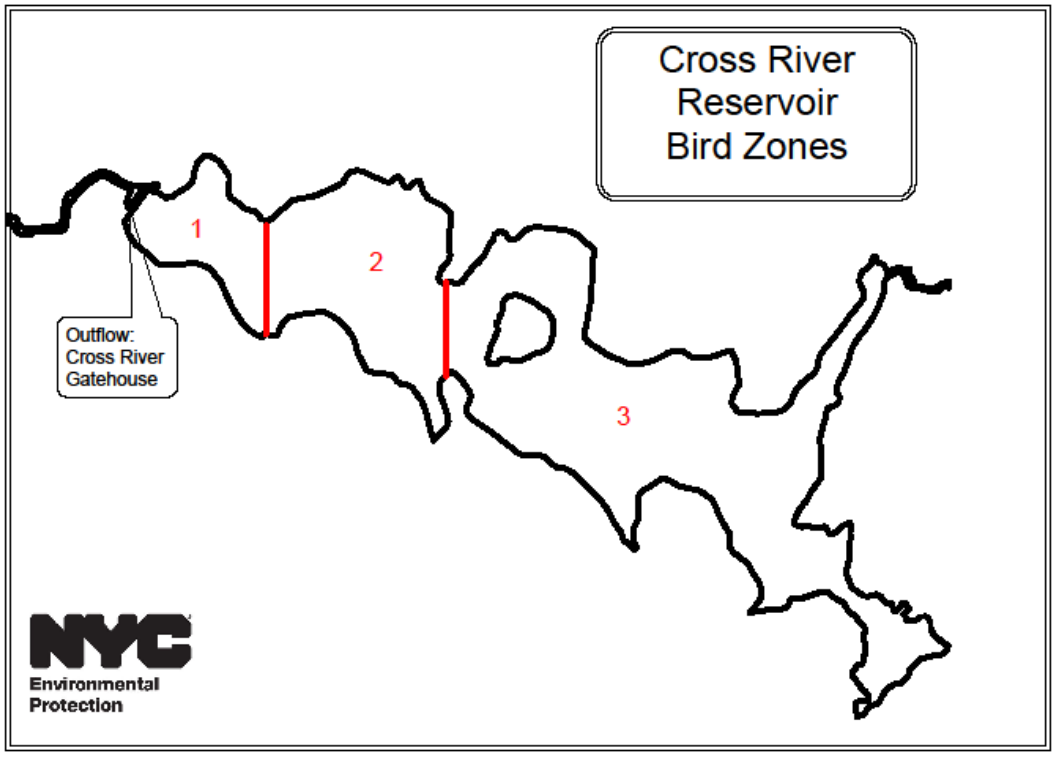

Figure 43. Map of Cross River Reservoir bird zones.

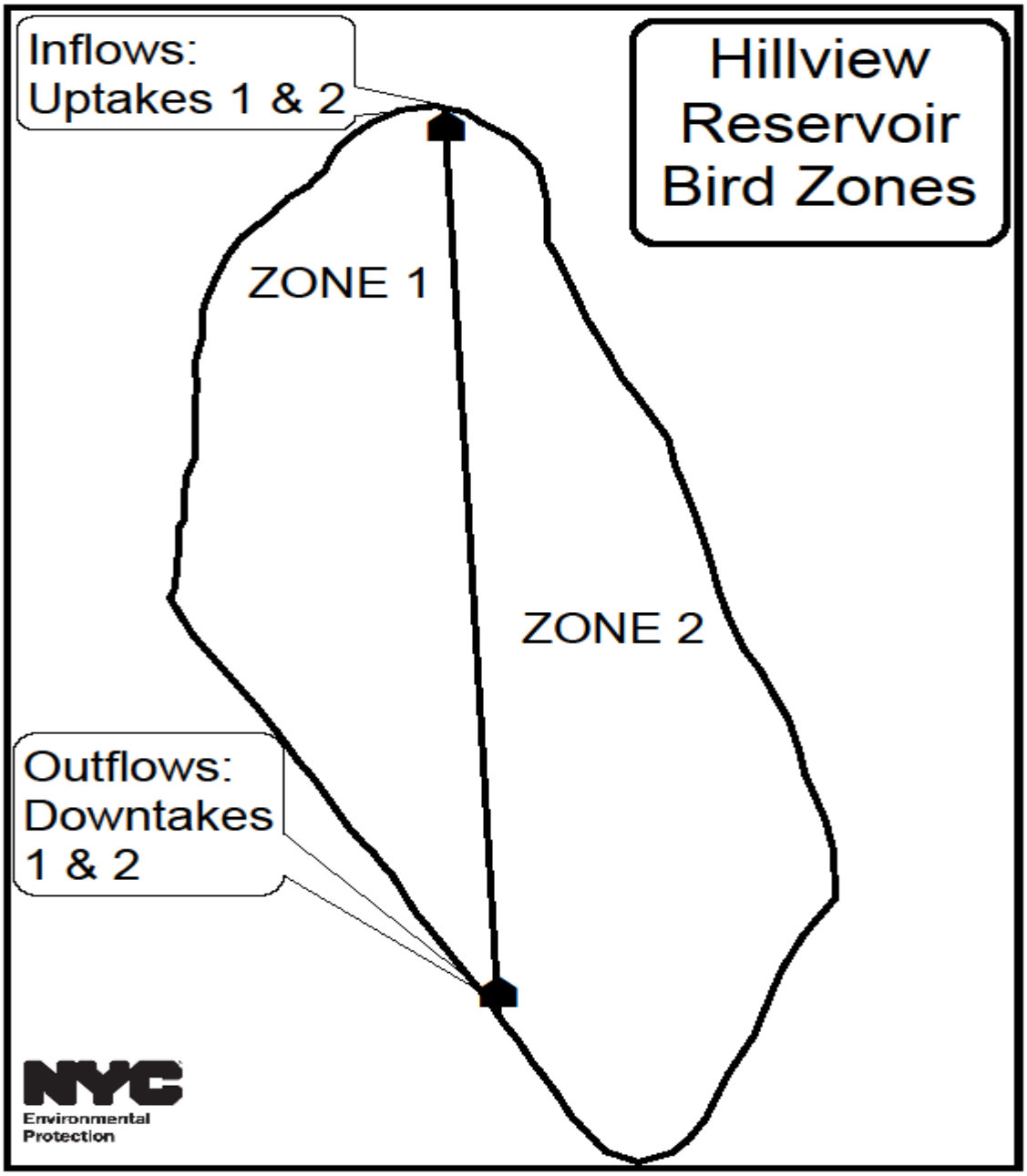

Figure 44. Map of Hillview Reservoir bird zones.

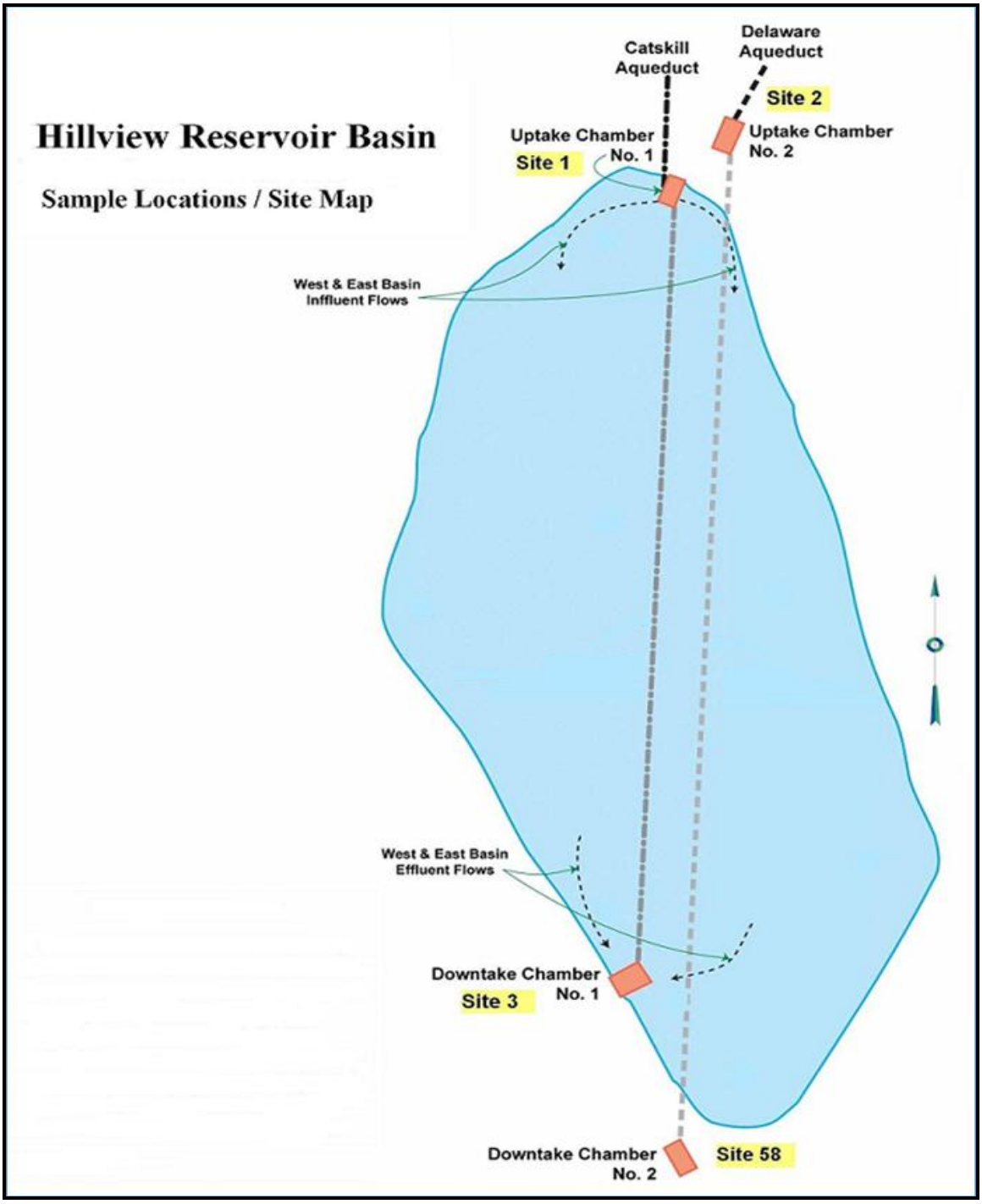

Figure 45. Map of Hillview Reservoir water sampling locations.