A REPORT TO
THE WATERSHED PROTECTION AND PARTNERSHIP COUNCIL EXECUTIVE COMMITTEE

FROM
THE WATERSHED PROTECTION AND PARTNERSHIP COUNCIL TECHNICAL ADVISORY COMMITTEE

RECOMMENDATIONS TO THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION FOR THE DEVELOPMENT OF ITS PHASE II TMDL IMPLEMENTATION PLAN

April, 2004

TABLE OF CONTENTS

CHAPTER 1 - COMMITTEE FUNCTIONS AND MEMBERSHIP

TECHNICAL ADVISORY COMMITTEE

Pursuant to Article IV of the New York City Watershed Memorandum of Agreement (MOA) the Parties agreed to create a Watershed Protection and Partnership Council (WPPC or Council) and committees to aid in the protection of drinking water quality and the economic vitality of the Watershed communities. The WPPC Technical Advisory Committee consists of fourteen (14) members and reports to the WPPC Executive Committee. All members of the Technical Advisory Committee (TAC) shall have the appropriate scientific or technical expertise to enable the TAC to fulfill its purposes.

As listed within the MOA, the TAC was given the power to:

- Advise the Council and its committees on scientific and technological developments in the field of water pollution control and water supply protection;
- recommend research needs within the Watershed;
- review scientific and technical proposals, studies, and reports;
- aid in the definition of water quality problems and their causes;
- establish any necessary subcommittees to analyze specific uses;
- alert the Council and its committees to emerging environmental and water quality problems within the Watershed; and,
- make recommendations and decisions regarding these duties and responsibilities.

The membership of the TAC is as follows:

Prof. Nicholas L. Clesceri, Ph.D, P.E., TAC Chair
Environmental Engineering Program Director
Rensselaer Polytechnic Institute
110 8th Street
Troy, NY 12180-3590

James Luke, P.E., Chief Engineer
NYC Department of Health
2 Lafayette Street, 11th Floor
New York, NY 10007

Jack Dunn, P.E.
NYS DOH, Flanigan Square
547 River St., Rm. 400
Troy, NY 12180-2216

René VanSchaack, Exec. Dir.
Greene County Soil/Water Conservation District
HC#3, Box 907
Cairo, NY 12413

Kenneth Markussen, P.E.
NYS DEC- Division of Water
625 Broadway- 4th Floor
Albany, NY 12233-3506

Michael Budzinski
Putnam County Health Department
1 Geneva Road
Brewster, NY 10509

John Lynch*
Director of Planning
Putnam County Planning Department
841 Fair Street
Carmel, New York 10512

Dean Palen, Public Health Director
Ulster County Health Dept.
300 Flatbush Avenue
Kingston, NY 12401-2740
Jeffrey Gratz

NYC Watershed Team Leader
US Environmental Protection - Region 2
290 Broadway - 28th Floor
New York, NY 10007-1866

Maureen Krudner - Alternate Designee
US Environmental Protection - Region 2
290 Broadway - 28th Floor
New York, NY 10007-1866

Michael Principe, Ph.D, Deputy Commissioner
NYC Department of Environmental Protection
465 Columbus Avenue
Valhalla, NY 10595

Kimberlee Kane, Ph.D*
NYC Department of Environmental Protection
465 Columbus Avenue
Valhalla, NY 10595

Michael Meyer*
NYC Department of Environmental Protection
465 Columbus Avenue
Valhalla, NY 10595

Bridget Barclay
Assistant Director
Dutchess Co. Water & Wastewater
27 High Street
Poughkeepsie, NY 12601

Gerard E. Mulligan, Commissioner
Westchester County Department of Planning
432 Michaelian Office Bldg.
White Plains, NY 10601

Sabrina Charney*
Westchester County Department of Planning
432 Michaelian Office Bldg.
White Plains, NY 10601

Alicia Terry
Director of Planning
Schoharie County Planning & Development Agency
349 Mineral Springs Road
Cobleskill, NY 12043

Ralph Huddleston, Senior Vice President
Carpenter Environmental Associates
307 Museum Village Road
PO Box 656
Monroe, New York 10950

Luis R. Marcos, M.D., President
NYC Health & Hospitals Corporation

*Not appointed as Designees pursuant to the WPPC bylaws Section 3.20, these individuals attended some or all of the TAC meetings listed below, and contributed to this report.

For the Watershed Protection and Partnership Council:

William C. Harding, Executive Director
Watershed Protection and Partnership Council
2 John Walsh Boulevard, Suite 206
Peekskill, New York 10566

Lisa Melville, Watershed Programs Coordinator
New York State Department of State
41 State Street
Albany, New York 12231

CHAPTER 2 - BACKGROUND, COMMITTEE CHARGE, SCOPE OF

WORK AND MEETING SCHEDULE

BACKGROUND

Paragraph 105©) of the 1997 New York City Watershed Agreement sets forth that on the fifth anniversary of the Agreement, the WPPC Executive Committee has the power to commence a review of:

- The implementation of the Watershed Regulations as set forth in Attachment W of the Agreement;
- The Watershed land acquisition program as set forth in Article II of the Agreement;
- Any comprehensive water quality monitoring programs in the Watershed;
- Any Watershed Protection and Partnership Programs set forth in Article V, and,

The WPPC Executive Committee did conduct such a review, and as part of the review, received reports from the City of New York and the State of New York regarding their respective activities regarding the implementation of the Agreement and other activities relating to the protection of water quality in the New York City Watershed.

Following a series of public comment opportunities on the implementation of the Agreement and on the City and State reports which were made publically available, the WPPC Executive Committee convened on August 14, 2002 and adopted a list of twenty-nine (29) "Priority Recommendations for MOA Programs".

CHARGE and SCOPE OF WORK

Introduction

On August 14, 2002, the Watershed Protection and Partnership Council (WPPC) made the following recommendation as part of the list of twenty-nine (29) "Priority Recommendations for MOA Programs":

"The Technical Advisory Committee of the WPPC should review the final Phase II Non Point Source TMDL Implementation Report prepared by DEC, solicit stakeholder input, and make recommendations to DEC on how to finalize the Report and to ensure the development of individual basin plans. The Report should be completed no later than 6 months after Croton Planning is complete. Projects identified in the Report should be implemented as soon as possible to maximize water quality improvements, and progress on implementation should be reported to the WPPC." [Paragraph 162: Total Maximum Daily Loads]

Background

Concurrent with EPA's approval of NYSDEC's "Phase II Phosphorus Total Maximum Daily Loads (TMDLs) for Reservoirs in the New York City Water Supply Watershed" in October 2000, the agency outlined eight components that are critical to a successful program to meet phosphorus reduction objectives. In March 2002, in accordance with the 1997 Watershed Memorandum of

Agreement (MOA), NYSDEC completed its "Interim Report - Nonpoint Source Implementation of the Phase II Phosphorus TMDLs in the New York City Watershed." This report highlighted that it was "interim" since it "[did] not include all of the specific implementation components outlined in the MOA and expanded upon in EPA's October 16, 2000 implementation strategy letter." The report also recognized that "the specifics for nonpoint source implementation are currently unavailable," and it identified specific informational needs (Section 1.3).

Objective

To make recommendations to NYSDEC for development of its Phase II TMDL Implementation Plan which should provide a reasonable assurance that TMDLs for each basin will be met and which should identify how local communities will be involved in developing site specific projects to achieve TMDL goals. The final report should also suggest a mechanism for evaluating the effectiveness of the implementation program over time.

Charge components

A. The Technical Advisory Committee (TAC) will review the NYSDEC March 2002 Report and determine the specific additional steps or data that are needed to adequately address the eight implementation plan components EPA has identified in its October 16, 2000 letter such that NYSDEC's Phase II TMDL Implementation Plan will meet the above objective. *(Note: As part of this charge, the TAC will also review the DEC Implementation Report, Phase II Stormwater Regulations, and associated institutional and technical issues.)*

The eight implementation plan components expressed in the EPA letter are:

1. For each upstream waterbody, quantification of additional load reductions (including reductions from point sources and non-point sources) above those required to meet the TMDL for that waterbody, that will result in achieving standards in downstream reservoirs;

2. Identification of management practices specific to the land use areas within each basin that may be implemented to meet the more stringent of either the TMDL for that waterbody or the reduced load necessary to achieve downstream standards;

3. A list of municipalities, and other storm sewer systems, by basin, that should be designated under the Phase II Stormwater Rule;

4. For each reservoir, management practices that will be implemented to achieve standards in that waterbody and achieve standards in downstream reservoirs;

5. A description of the implementation mechanism/institutional framework;

6. The time frame for implementing the actions;

7. Funding sources for implementation; and

8. A plan for evaluating/monitoring the effectiveness of the management practices.

B. The TAC will recommend how and from whom to obtain this additional information, along with a schedule. (The TAC will report on what additional information is necessary, and from whom it can be obtained.)

C. The TAC will provide recommendations on the necessary stakeholder input and stakeholder commitments for plan finalization, such that implementation of the Phase II TMDL Implementation Plan will meet the phosphorus goals of the TMDL. (The TAC will include input type, opportunities and timeframe. Note that commitments follow the development of plan specifics.)

D. The TAC will review the draft and final (if available) Croton Plans for specific commitments. (Necessary for Item A.4, above.)

E. TAC will provide specific recommendations to NYSDEC on finalizing the Phase II TMDL Implementation Plan for achieving nonpoint source reductions in the NYC Watershed.

Information provided

To assist in completing the charge, the TAC will be provided with the following information.

- EPA's letter to NYSDEC dated October 16, 2000
- NYSDEC's Interim Report on Nonpoint Source Implementation of the Phase II Phosphorus TMDLs in the New York City Watershed (March 2002)
- NYSDEC and NYCDEP's Nonpoint Source Implementation of the Phase II TMDLs Report (April 2001)
- Current status of the Westchester and Putnam County Croton Plans (along with outlines and available drafts)
- Current status of the NYC Croton Watershed Strategy (along with outlines and available drafts)

Timeframe

The TAC will submit a schedule for completing the above charge. The schedule includes the submission of all TAC recommendations prior to the date by which the Croton Plans are finalized.

Reporting

The TAC will develop a process for reporting progress to the WPPC. The TAC will make periodic reports to the WPPC as necessary, through the offices of the WPPC Executive Director.

MEETING SCHEDULE

The TAC followed an aggressive meeting schedule. Overall, the TAC met twelve times, beginning with an initial meeting on January 28, 2003.

The meeting schedule was as follows:
January 28, 2003
February 27, 2003
March 28, 2003
May 1, 2003
May 29, 2003
July 10, 2003
September 18, 2003
October 16, 2003
November 20, 2003
December 18, 2003
January 15, 2004
February 26, 2004

CHAPTER 3 - THE TECHNICAL ADVISORY COMMITTEE REPORT

Charge Component A.1

"For each upstream waterbody, quantification of additional load reductions (including reductions from point sources and non-point sources) above those required to meet the TMDL for that waterbody, that will result in achieving standards in downstream reservoirs."

Introduction

The original Phase II TMDL analyses determined the Total Load Reduction required for each reservoir to meet its TMDL as well as simple estimates of the load reductions expected from the planned Wastewater Treatment Plant (WWTP) upgrade program and future compliance in upstream reservoirs. While these basin-scale values are useful, the complex interrelated nature of the Croton system requires additional refinement of the calculations to ensure compliance in all the reservoirs. Furthermore, the actual implementation of the reductions will occur at the municipal level and therefore further spatial detail is necessary. The report entitled "Nonpoint Source Implementation of the Phase II TMDLs" (NYCDEP, NYSDEC, 2001) discussed many issues involved in allocating these reductions to watershed municipalities and presented sample allocations. These calculations did not include additional reductions to ensure downstream compliance, and left many policy issues undecided.

Recommendation

In accordance with Components A.1 and E of the Charge, the TAC recommends that the following analysis, performed by the TAC, be included in NYSDEC's Phase II TMDL Implementation Plan:

The TAC reviewed the available information, and through an iterative process, determined certain guidelines for allocating phosphorus load reductions in the Croton System. The basic guidelines are:

- Utilize the same information developed for the Phase II TMDL analyses.
- Assign load reductions to municipalities proportional to their existing loads as determined through the watershed modeling.
- Maximize the load reduction allocated to the individual reservoir basin before allocating reductions upstream but assume each reservoir basin can achieve reductions of no more than 40% of their existing nonpoint source load from in-basin sources. Any additional reductions must be obtained from upstream sources.
- Recalculate the reduction due to compliance of upstream reservoirs to fully account for anticipated phosphorus retention within the upstream reservoirs.
- Exclude the West Branch and Bog Brook reservoirs from the analysis. These basins are in compliance with their TMDLs and the phosphorus load transmitted downstream from the West Branch Reservoir is not controlled by watershed sources.
- Exclude Connecticut from the allocations.
- Defer complete compliance for Diverting Reservoir and assume a 40% reduction of in-basin nonpoint sources and reductions due to upstream compliance of East Branch Reservoir.

The TAC also determined that two separate scenarios of phosphorus reduction allocations should be evaluated to fully address this scope of work component.

> **Scenario #1 –** calculate in-basin and upstream reductions for all reservoirs and allocate these reductions to the municipalities according to the guidelines presented above.
>
> **Scenario #2 –** identical to Scenario #1 except with more stringent Wasteload Allocations for the wastewater treatment plants.

The Phase II Wasteload Allocations for each wastewater treatment plant were calculated from the maximum permitted flow and phosphorus effluent concentrations contained in the plant's post-upgrade SPDES permit. The phosphorus effluent concentrations in the Watershed Rules and Regulations vary from 0.2 mg/l to 1.0 mg/l depending on flow, with higher effluent concentrations for smaller WWTPs. Since the treatment technology is the same for all plants, Scenario #2 revises the wasteload allocations by assigning all WWTPs with flows less than 500,000 gpd a phosphorus effluent concentration of 0.3 mg/l. The WWTPs with flows greater than 500,000 gpd are unchanged and have a phosphorus effluent concentration of 0.2 mg/l.

These allocations of nonpoint source reductions are provided for planning purposes only. Nonpoint source loads vary tremendously from season to season, and year to year. The calculations conducted here estimate the reductions necessary to achieve the target reservoir concentration as a growing-season average over several years.

Phosphorus Reduction Allocations

The following is a summary of the results and a comparison of the two scenarios. The data and detailed calculations are provided in Appendix A.

Allocations by Reservoir Basin

The calculated phosphorus load reductions by reservoir basin are given in Tables 1 and 2:

> Total load reduction: total reduction required for that individual basin to meet its own TMDL (as given in the Phase II TMDLs).
> Total WWTP reduction: reduction anticipated due to the WWTP upgrade program.
> Total NPS reduction: remaining reduction after the WWTP reduction is subtracted from the Total load reduction. This reduction is then allocated to in-basin sources and upstream sources.
> Upstream compliance: estimated load reduction once any upstream basins are in compliance with their own TMDLs.

In-basin NPS reduction:

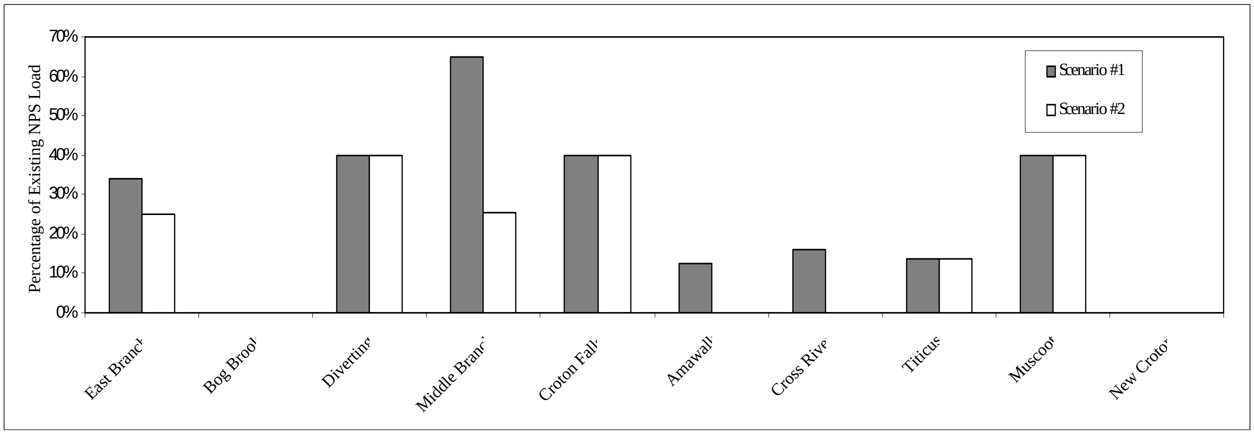
> Basin TMDL: in-basin NPS reduction to achieve that individual TMDL. If upstream basins exist, then this reduction is fixed at 40% of the existing NPS load and any additional reductions are allocated to upstream sources.
> Downstream compliance: additional reductions required to achieve downstream compliance (includes the effects of in-reservoir retention).
> Total in-basin: Sum of the reductions required within the basin for compliance with its own TMDL (Basin TMDL) and any additional reductions for downstream reservoirs (Downstream compliance).

<u>% of Existing NPS load</u>: The Total In-basin load reduction is divided by the modeled NPS load for the basin (conducted as part of the Phase II TMDL analysis) to determine the percentage reduction required (See Table 2, Appendix A).
<u>Reduction allocated upstream</u>: the portion of the load reduction that is required from upstream sources, above compliance with their own TMDLs, in order to achieve downstream compliance. The load listed for the Croton Falls basin is allocated to the Middle Branch basin; the load listed for the Muscoot basin is allocated to the Cross River basin.

For example (See Table 1, Page 13): Croton Falls requires a Total load reduction of 1980 kg/yr to achieve the PhII TMDL. Once the WWTPs are upgraded, the load from point sources will be reduced below 1996 levels by 1095 kg/yr. The remaining reduction of 885 kg/yr will need to come from a combination of in-basin and upstream NPS. When Middle Branch Reservoir is in compliance and the Diverting Reservoir concentration reduced, the load reduction to Croton Falls Reservoir will be 377 kg/yr. The Croton Falls basin is allocated a reduction of 40% of its modeled current NPS (779 kg/yr) resulting in an in-basin reduction of 312 kg/yr. The modeled current NPS in-basin load is derived from watershed modeling. Upstream compliance (377 kg/yr) and in-basin reductions (312 kg/yr) combined yield a total reduction of 689 kg/yr, which is 196 kg/yr short of the required NPS reduction of 885 kg/yr. The remaining196 kg/yr is allocated upstream, in this case to the Middle Branch basin. In order to lower the outflow concentration, and related load, from Middle Branch Reservoir, the Middle Branch basin must achieve a reduction of 381 kg/yr. The higher load reduction required within the Middle Branch basin is due toretention within the reservoir.

These load reductions are best placed in context by comparing them to the modeled nonpoint source load. Figure 1 shows the nonpoint source load reductions per basin as a percentage of the existing nonpoint source load. Some reservoirs have higher phosphorus concentrations and require greater reductions to comply with the Phase II TMDLs, and some reservoirs are already in compliance or will be with the additional point source reductions in Scenario #2.

Figure 1. Phosphorus Reduction as a Percentage of Existing Nonpoint Source Load by Reservoir.



Note: Croton Falls, Diverting and Muscoot reservoirs have their reduction percentage fixed at 40% of their existing nonpoint source load. Reductions required above this level are allocated to upstream reservoirs. Middle Branch Reservoir demonstrates the greatest change between scenarios. This is due to less reductions required within the Croton Falls basin and therefore less reductions allocated upstream to the Middle Branch Reservoir.

Table 1. Scenario #1 Phosphorus Load Reductions by Reservoir Basin.

	Total load reduction (kg/yr)	Total WWTP reduction (kg/yr)	Total reduction (kg/yr)	Upstream compliance (kg/yr)	In-basin NPS Reduction: Basin TMDL (kg/yr)	Downstream compliance (kg/yr)	Total In-basin (kg/yr)	% of Existing NPS load (kg/yr)	Reduction allocated upstream (kg/yr)
East Branch	993	0	993	0	993	0	993	34%	0
Bog Brook	0	0	0	0	0	0	0	0%	0
Diverting	1452	0	1452	577	243	0	243	40%	0
Middle Branch	204	0	204	0	204	381	585	65%	0
Croton Falls	1980	1095	885	377	312	0	312	40%	196
Amawalk	122	0	122	0	122	0	122	12%	0
Cross River	57	0	57	0	0	163	163	16%	0
Titicus	140	0	140	0	140	0	140	14%	0
Muscoot	3103	226	2877	1038	1734	0	1734	40%	104
New Croton	2431	0	2431	2678	0	0	0	0%	0

Table 2. Scenario #2 Phosphorus Load Reductions by Reservoir Basin.

	Total load reduction (kg/yr)	Total WWTP reduction (kg/yr)	Total NPS reduction (kg/yr)	Upstream compliance (kg/yr)	In-basin NPS Reduction: Basin TMDL (kg/yr)	Downstream compliance (kg/yr)	Total In-basin (kg/yr)	% of Existing NPS load (kg/yr)	Reduction allocated upstream (kg/yr)
East Branch	993	256	737	0	737	0	737	25%	0
Bog Brook	0	19	0	0	0	0	0	0%	0
Diverting	1452	39	1413	577	243	0	243	40%	0
Middle Branch	204	92	112	0	112	118	230	26%	0
Croton Falls	1980	1278	702	377	312	0	312	40%	13
Amawalk	122	189	0	0	0	0	0	0%	0
Cross River	57	50	7	0	0	0	0	0%	0
Titicus	140	0	140	0	140	0	140	14%	0
Muscoot	3103	653	2450	1038	1734	0	1734	40%	0
New Croton	2431	110	2321	2678	0	0	0	0%	0

Allocations by Municipality

The percentage of the nonpoint phosphorus load contributed by each municipality to each reservoir basin is given in Table 3. This load percentage is determined by the area in each reservoir basin as well as the respective land uses. These percentages are used to allocate the phosphorus reductions. The total load reduction required for each municipality for each scenario is provided in Table 4. The calculated phosphorus load reductions by municipality, for each scenario, as a percentage of their existing nonpoint source load are given in Figure 2. Municipalities with the greatest change between scenarios are the ones within the Middle Branch basin.

Table 3. Percentage of Nonpoint Source Phosphorus Load Contributed by Each Municipality.

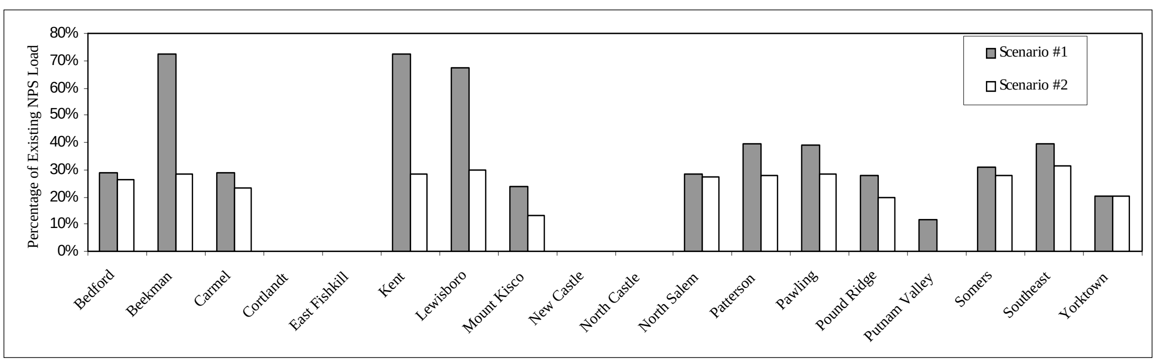
	Total NPS Load	East Branch	Bog Brook	Diverting	Middle Branch	Croton Falls	Amawalk	Cross River	Titicus	Muscoot	New Croton
Bedford	1800							29.7%		27.1%	11.6%
Beekman	24	0.0%			3.0%						
Carmel	1542				4.4%	85.2%	61.7%			4.7%	
Cortlandt	208										7.8%
East Fishkill	93				11.5%						
Kent	430	0.5%			44.6%	7.4%					
Lewisboro	947							60.4%	5.5%	6.8%	
Mount Kisco	392										14.6%
New Castle	799										29.8%
North Castle	6										0.2%
North Salem	1061	2.6%						0.3%	94.5%	8.1%	
Patterson	1044	36.5%	11.7%	0.5%	8.5%						
Pawling	721	26.8%			2.7%						
Pound Ridge	193							9.6%		2.2%	
Putnam Valley	39						3.6%				
Somers	1570					2.3%	34.7%			24.9%	3.2%
Southeast	2109	33.6%	88.3%	99.5%	25.3%	5.2%				5.4%	
Yorktown	1789									20.8%	32.7%

Notes:
-"Total NPS Load" is the modeled load for that portion of each municipality in the Watershed.
-All columns add to 100%.

Table 4. Total Phosphorus Load Reduction by Municipality.

	Scenario #1 (kg/yr)	Scenario #2 (kg/yr)
Bedford	518	470
Beekman	17	7
Carmel	448	357
Cortlandt	0	0
East Fishkill	0	0
Kent	67	26
Lewisboro	289	129
Mount Kisco	224	126
New Castle	0	0
North Castle	0	0
North Salem	299	291
Patterson	413	290
Pawling	282	204
Pound Ridge	53	38
Putnam Valley	4	0
Somers	482	440
Southeast	833	657
Yorktown	361	361

Figure 2. Phosphorus Reduction as a Percentage of Existing Nonpoint Source Load by Municipality.



Additional Considerations

1. Northern Westchester Diversion

At this time, there are a number of wastewater diversion plans under consideration in the Westchester County portion of the Croton watershed. One of these plans, the Northern Westchester Diversion, has the potential to significantly impact TMDL implementation plans for the watershed. The Northern Westchester Diversion proposes to divert the Yorktown (Muscoot), Riverwoods (New Croton) and Baldwin Place (Amawalk) WWTPs off the watershed. The total WLA for these three plants is 508 kg/yr. By removing these allocations, and comparing the results to Scenario #1:

- Additional upstream reductions (beyond TMDL compliance) are no longer required for Muscoot to come into compliance;
- NPS reductions are reduced or eliminated for Amawalk, Muscoot and Cross River basins, making TMDL compliance more feasible.
- NPS reductions for the towns of Bedford, Carmel, Mount Kisco and North Salem are also reduced.

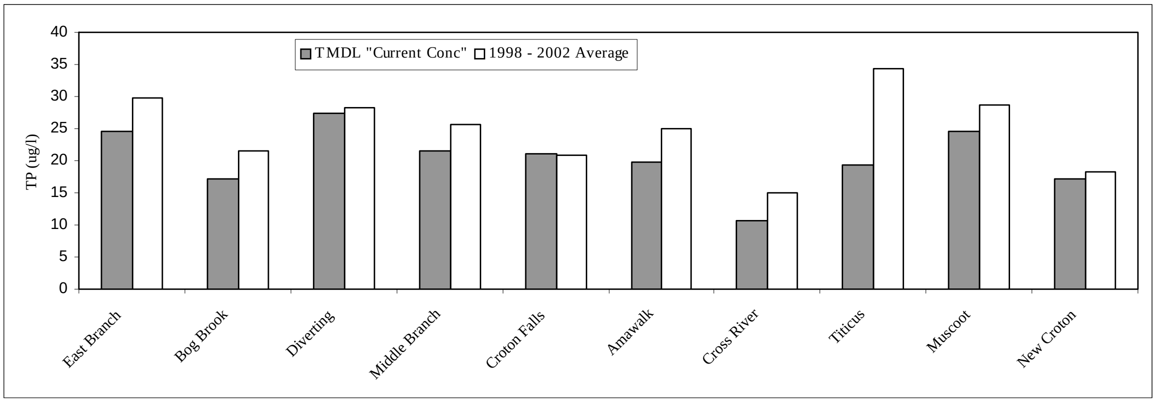
Table 5. Change in Total Phosphorus Load Reduction Allocations with Diversion.

	NPS Reduction (% existing load)	
	Scenario#1	With Diversion
Amawalk	12%	9%
Muscoot	40%	33%
Cross River	16%	0%
Bedford	29%	21%
Carmel	29%	27%
Mount Kisco	24%	11%
North Salem	28%	26%

2. "Current" Reservoir Concentrations

The TAC decided it was most appropriate to utilize the same data and information to allocate the phosphorus reductions as was used to develop the Phase II TMDLs. Unfortunately, the reservoir Total P concentrations in some cases have increased over time and this should be kept in mind when planning for the phosphorus reductions. In the Phase II TMDL calculations, the required total phosphorus reductions were determined by comparing each reservoir's Available Load to the Current Load. The Current Load for each reservoir was backcalculated from monitored phosphorus concentrations in the reservoir for the same five year period as the TMDL (1992 – 1996). Figure 3 shows the Current Concentration used in the TMDL analysis for each reservoir which was calculated from data collected during 1992 – 1996, compared to the 1998 – 2002 concentration. While some reservoirs have only changed marginally, such as Croton Falls Reservoir, other reservoirs have experienced a more significant increase in phosphorus concentrations during this time period. Titicus Reservoir has the largest increase but this is most likely due to the dam rehabilitation and not an actual increase in load from the basin. Sometimes after a lake or reservoir has been completely drained for a period of time, phosphorus concentrations will be elevated for a few years until the reservoir equilibrates.

Figure 3. Reservoir Phosphorus Concentrations.



Charge Components A.2 & A.4

A.2 - "Identification of management practices specific to land use areas within each basin that may be implemented to meet the more stringent of either the TMDL for that waterbody or the reduced load necessary to achieve downstream standards."

A.4 - "For each reservoir, management practices that will be implemented to achieve standards in that waterbody and achieve standards in downstream reservoirs."

Introduction

In accordance with the NYC Watershed MOA, NYCDEP and NYSDEC jointly issued a report in April 2001 which identified potential management practices for controlling nonpoint source pollution. This report discussed existing programs and ongoing efforts to control phosphorus. It also included a list of generic management practices for urban areas. The "Interim Report - Nonpoint Source Implementation of the Phase II Phosphorus TMDLs in the New York City Watershed" was unable to take the next step of identifying management practices that will be implemented because the necessary information was not available at the time. Since mid-2001, the draft Croton Plans for Putnam and Westchester Counties have been prepared and NYCDEP's "Croton Watershed Strategy" and "Nonpoint Source Management Plan" for East-of-Hudson (EOH) basins have been completed. These documents contain information that is integral to the development of basin-specific implementation plans. NYSDEC recognized that decisions regarding specific practices to control nonpoint sources are best linked to the local decision making process.

Recommendations

In accordance with Components A.2 and A.4, and Components B through E of the Charge, the TAC recommends the following actions (with corresponding recommended timeframes):

1. *Individual management plans for each basin, identifying specific management practices, need to be developed and incorporated as part of the Phase II TMDL Implementation Plan.*

    a. NYSDEC should compile, by basin, the following information:

        i. areas of concern and recommendations for management alternatives from NYCDEP's Croton Watershed Strategy,

        ii. actions being taken pursuant to NYCDEP's Nonpoint Source Management Plan

        iii. planned and possible solutions from the Croton Plans for Putnam and Westchester Counties,

        iv. ongoing State projects (e.g. NYSDOT), and

        v. ongoing projects funded through SDWA, WRDA, Section 319 and SRF grant programs

    Timeframe: June 2004

b. NYSDEC should develop a draft implementation plan for each basin that relates potential and ongoing projects to areas of concern.
Timeframe: July 2004

c. For each basin, NYSDEC and the implementing agencies should finalize an implementation plan that includes specific projects, the implementing agency, an estimated schedule and possible funding sources.
Timeframe: October 2004

2. *An active outreach program to localities that will be implementing projects needs to be developed.* (See Figure 4, Page 23.)

a. NYCDEP should provide summary reports of the Croton Watershed Strategy, designed for general use by stakeholders, to NYSDEC for use in its outreach efforts.
Timeframe: March 2004

b. NYSDEC should conduct general information sessions for local agencies. These sessions will:
i. focus on the coordination between TMDL implementation, Phase II Stormwater compliance and Croton Plan implementation,
ii. explain the technical information available, the necessary phosphorus reductions per basin and the institutional framework envisioned by NYSDEC to implement and track implementation (see Component A.5, Page 26),
iii. demonstrate how local agencies can maximize their resources while achieving water quality goals,
iv. describe funding opportunities, and
v. explain and propose the concept of draft and final Phase II TMDL Implementation Plans to local agencies and receive feedback on the process for finalizing individual basin plans.
Timeframe: June 2004

c. Meetings to finalize Phase II TMDL Implementation Plan will be held consistent with the process agreed to during the general information sessions.
Timeframe: September 2004

d. NYSDEC should hold information sessions for all watershed stakeholders (i.e. MOA parties, environmental groups) on the individual basin plans contained within the Phase II TMDL Implementation Plan.
Timeframe: October 2004

3. *NYSDEC should provide technical assistance and training to wastewater treatment plant operators to optimize their phosphorus reduction capabilities.*
4. *NYSDEC should include the following minimum conditions in a special EOH Stormwater Permit in order to address existing sources of pollution. These conditions will assist*

EOH Municipal Separate Storm Sewer Systems (MS4s) meet phosphorus TMDL reduction levels:

a. In addition to the required outfall mapping as outlined in the USEPA Stormwater Phase II regulations, an EOH Permit should require, at a minimum, that each MS4 map its entire stormwater conveyance system by a date to be determined by NYSDEC. This includes mapping of all inflows, intakes and connections, roads (paved, unpaved curbed and uncurbed), swales (including road side drainage and catchbasins), detention and retention ponds, infiltration basins, and parking lots.

All information should be provided in digital format suitable for use in GIS software (preferably ESRI ArcGIS). The scale should be 1:2400 or better. Other characteristics that should be captured include:

i. pipe size,
ii. dimensions/size of basin,
iii. identification of whether or not property is publicly or privately owned,
iv. property owner name,
v. easement information (if applicable),
vi. maintenance responsibility, and
vii. Property use code

b. Each MS4 shall develop a Stormwater Conveyance System inspection and maintenance schedule. Such a schedule shall include a map identifying the location and maintenance schedule for each component of the stormwater system. Inspections and maintenance shall also apply to all outfalls, which shall be inspected for non-stormwater discharges and the bank stability of the receiving waterbody. The maintenance schedule for all stormwater infrastructure should conform to the NYS Stormwater Management Design Manual (10/01). For other components of the stormwater conveyance system and best management practices, inspections shall occur no less than annually, preferably every 6 months. Routine maintenance and clean-out of catch basins or other inflows to the stormwater conveyance system shall occur not less than twice per year.

A Corrective Action Plan shall be developed for each Stormwater Conveyance System component that has been identified as needing repair. A file of all corrective actions implemented and illicit discharges detected and repaired shall be maintained for a period of not less than five years.

c. A comprehensive street sweeping program should be developed by each EOH municipality to better protect water quality through street sweeping[1]. (Street sweeping decisions are often based on performance failures or complaints, not

---

[1] A brief study of street sweeping in the Middle Branch basin showed phosphorus levels in the street debris to be significant (~ 400 mg phosphorus per kg of debris). For each 100 curb miles cleaned, approximately 60 kg of phosphorus can be removed. While not all of the phosphorus ends up in the nearby streams, as a regular practice it can be an effective source control method.

water quality). Municipal street sweeping programs should be coordinated with adjacent municipalities where subwatershed areas are divided by municipal boundaries to ensure that sweeping efforts are undertaken for water quality protection purposes. A comprehensive street sweeping program should include:

i. Targeting areas with the highest pollutant loading (industrial and commercial areas) for more frequent sweeping and sweeping prior to rainy weather;
ii. Identification of subwatersheds where municipal street sweeping coordination is necessary;
iii. Designing sweeping routes based on street loading, travel time to and from route and disposal site, and frequency of sweeping;
iv. A restriction of vehicle parking through education and regulation to allow for routine sweeping;
v. Inspection of sweeping route immediately after cleaning to evaluate effectiveness;
vi. Maintenance of computerized route logs with calculation of curb miles swept and amount of debris removed;
vii. Analysis of street sweeping debris to determine composition (NYCDEP has offered analysis assistance);
viii. Re-evaluation of operation and routes through day-to-day management;
ix. Training for highway personnel to teach safe and proper use of sweeping equipment; and
x. Education of local officials and citizens regarding the importance of street sweeping and well developed street sweeping program.

d. Each EOH municipality should have a Snow and Ice Operational Plan. Currently, municipalities that maintain state roads are required to provide the state with Snow and Ice Operational Plans which specify the types of equipment used, the source and storage of materials, and the application and calibration methods used with winter materials. Each EOH municipality, regardless of whether or not they maintain state roads, should develop a Snow and Ice Operational Plan for their entire community, including state roads. The operation plans should include equipment specifications, guidelines for source and storage of materials, and application and calibration methods. In addition, the following measures should be included in the plans and implemented by each EOH municipality:

i. Make all material storage facilities permanent structures and fully enclose them;
ii. Mix/handle and load all winter materials in covered areas;
iii. Install drainage and stormwater collection systems around the perimeter of storage areas to prevent salt and sediment loss to groundwater aquifers or nearby waterways;
iv. Wash salt trucks in designated areas designed to collect all resulting runoff;
v. Remove spilled salts and excess materials remaining in trucks, yards or on roads after every storm;

vi. Routine calibration of spreading equipment should be conducted throughout the winter season;

vii. Coordination of snow and ice removal with maintenance of the stormwater conveyance system (i.e. street sweeping and stormwater/catch basin cleaning);

viii. Explore new technologies as made available;

ix. Plans should include specific procedures for handling and storing road sand and salt. Proper containment of road sand and salt is imperative for water quality protection; and

x. The use of de-icing materials containing elevated levels of phosphorus should be avoided where possible.[2] If de-icing materials containing phosphorus are to be used on roadways within the municipality, documentation of such use, including quantity estimates, shall be included in the Snow and Ice Operational Plan.

e. Each EOH municipality should create a turf management and mowing practices and procedures policy for municipally-owned lands. Such policy should include the following:

i. Application of any phosphorus-containing fertilizer (as labeled) shall only be allowed following a proper soil test and analysis documenting that soil phosphorus concentrations are inadequate;

ii. Proper disposal and removal of grass clippings after mowing. Disposal should occur using a containment device so that they cannot enter the stormwater conveyance system and impact water quality;

iii. Specific procedures should be developed regarding mowing practices under drought conditions;

iv. For maximum water quality benefits, a vegetated swale should never be cut shorter than the design flow depth. Design flow depth and other associated information should be readily available to highway and public works personnel; and

v. Wildflowers and other native plant material should be used to lessen the frequency of mowing and employing the use of chemicals to control vegetation.

f. The WPPC TAC emphasizes the value of education in relation to phosphorus reduction. As such, the TAC encourages distribution of the NYSDEC's informational materials developed for school districts to the EOH municipalities. In addition, specific educational information should be developed regarding the following topics and phosphorus reduction:

i. understanding the phosphorus issue,

ii. septic systems, and

iii. fertilizers (store bought, leaves, grass clippings).

[2] The NYSOAG has investigated phosphorus levels in various deicer materials and found that some products contain significant amounts of phosphorus. See http://www.oag.state.ny.us/environment/deicer.html for more information.

g. All information generated by a municipality in completing the MS4 requirements shall be made available to DEC, regulatory agencies and the public at large.

Figure 4:
Recommended Timetable for
Rollout of Phase II TMDL Implementation Plan

June 2004	Compile information by basin from Croton Plans, Croton Watershed Strategy and State projects
June 2004	Information Sessions held for municipalities
July 2004	Develop draft Phase II TMDL Implementation Plan (with Basin Implementation Plans)
August/September 2004	Follow-up contact with municipalities to further develop the Implementation Plan.
October 2004	Finalize and Issue Phase II TMDL Implementation Plan
October 2004	Public Meetings with watershed stakeholders

Charge Component A.3

"A list of municipalities, and other storm sewer systems, by basin, that should be designated under the Phase II Stormwater Rule"

Introduction

Subsequent to EPA's October 16, 2000 letter, NYSDEC designated the entire EOH watershed as an urbanized area, subject to the Phase II Stormwater Rule. As a result, all municipalities are "designated under the Phase II Stormwater Rule," as are all non-traditional MS4s (school and other special districts, public housing authorities, State and federal hospitals, etc.) in the EOH watershed. Many non-traditional MS4s may not be aware of their status. The TAC recognizes that the burden to comply with the Rule lies with the MS4. However, in order for NYSDEC to effectively enforce the MS4 and Construction General Permits, it must know who the regulated entities are. While this may be a daunting task on a statewide basis, the EOH watershed can be a demonstration of an effective way to identify and reach out to the regulated community, in particular, the non-traditional MS4s. Several of the TAC's recommendations, below, address this issue.

Additionally, the TAC believes it is the overarching intent of this charge component that the Phase II Stormwater Permit program be effectively utilized to achieve necessary TMDL reductions. The TAC notes that where a TMDL has been approved by EPA for any waterbody or watershed into which a MS4 discharges (as is the case for the EOH watershed), the MS4 must review the applicable TMDL to see if it includes requirements for control of stormwater discharge. The MS4 is responsible for reviewing its Stormwater Management Plan to ensure it addresses a reduction of phosphorus as required by the TMDL. To help achieve this program objective, the TAC is providing recommendations to ensure effective implementation of the Phase II Stormwater Permit program in the EOH watershed.

Recommendations

In accordance with Components A.3, B and E of the Charge, the TAC recommends the following actions (with corresponding timeframes):

1. NYSDEC should contact by letter each of the State agencies which is likely to own and operate a stormwater conveyance system. NYSDEC should request facility-specific information for each agency's stormwater system(s) in the EOH watershed, and ensure that a stormwater management program consistent with the TMDL is in place.
   Timeframe: April 2004

2. NYSDEC should contact by letter each school district and provide the "Decision Tree" that was developed by DEC so the district can determine if it is an MS4.
   Timeframe: April 2004

3. NYSDEC should contact by letter each municipal MS4 and:

a. inform the MS4 that stormwater runoff originating from privately owned facilities such as office parks, residential developments and shopping malls, and discharging into the stormwater conveyance system of the MS4, is the responsibility of the MS4. The Stormwater Management Program that the MS4 develops, must address runoff from these sources.

b. request assistance from the traditional MS4 in the identification of non-traditional MS4s located within its municipal boundary.

c. encourage the MS4 to complete its required storm sewer system mapping as soon as possible. This will assist the MS4 in identifying major contributors to its system and to identify non-traditional MS4s within its geographic boundary. (This activity could be required in the EOH Permit on an accelerated schedule).

d. notify the municipal MS4 that it is in a TMDL basin and inform the MS4 of its responsibility to review its Stormwater Management Plan to ensure it addresses a reduction of phosphorus as required by the TMDL.

Timeframe: April 2004

4. Upon the identification of MS4s that have not filed a Notice of Intent, NYSDEC should contact the facility and ensure that permit requirements are complied with.
Timeframe: Within 60 days of identification

5. NYSDEC should provide MS4s in the EOH watershed clear guidance on permit compliance.
Timeframe: Consistent with outreach timeframes recommended for Components A.2 and A.4

Charge Component A.5

"A description of the implementation mechanism"

Introduction

The TAC agrees that an important component of any TMDL implementation mechanism will be an effective institutional framework. That framework should provide a strong link between New York State's TMDL implementation program and the system of local county, town and village governments in the Croton watershed, whose individual local land use authorities will provide the bulk of the decision making with regard to physical TMDL implementation. Stakeholder understanding and participation is essential to the success of the program.

Recommendations

In accordance with Components A.5 and E of the Charge, it is proposed that the WPPC TAC assume the role of a facilitative oversight body in order to provide an ongoing, technically oriented, implementation mechanism for meeting TMDL goals.

Generally, it is proposed that the TAC's TMDL-related responsibilities include:

- assisting NYSDEC track the progress of its forthcoming Phase II TMDL Implementation Plan for the Croton System and providing a comprehensive status report to the State at least every 2 years,
- performing all TAC-delegated actions specified in NYSDEC's Phase II TMDL Implementation Plan (e.g., actions related to evaluating and monitoring the effectiveness of the program - Component A.8),
- assisting counties, towns and villages to set goals and phosphorus reduction priorities,
- providing for information sharing through the creation of a central access point for TMDL technical and funding guidance,
- working with NYSDEC to facilitate necessary stakeholder involvement and dissemination of progress information to the public,
- maintaining a 'front burner' approach to TMDL implementation in the Croton System; and
- meeting at least quarterly to implement/oversee the above actions.

Timeframe: Immediately upon WPPC approval and authorization. Timeframes for some of the above actions are specified in Component A.8. Others will be developed within the State's Phase II TMDL Implementation Plan.

Charge Component A.6

"The time frame for implementing the actions"

Introduction

The TAC believes that explicit schedules are a critical means to track progress of the Phase II TMDL Implementation Plan and to gauge its success. If a particular project is falling behind schedule, the implementing organization may consider shifting funds to projects that will have a better chance of reaching completion. The TAC, in its proposed oversight role, could also make recommendations to the implementing organization based on a review of progress in meeting milestones. (The TAC does acknowledge that, in most cases, these schedules will not be "enforceable" through this program and will be dependent on the availability of funding.)

Recommendations

In accordance with Components A.6 and E of the Charge, the TAC recommends the following actions:

1. NYSDEC should include in its Phase II TMDL Implementation Plan a schedule or time frame for every action item in the Plan, even if that action item is in the planning or conceptual stage.

2. To the extent practicable, actions with multiple stages or are long term in nature should include interim milestone dates.

Charge Component A.7

"Funding sources for implementation"

Introduction

An effective TMDL implementation program requires adequate sources of funding. Further, in order to provide assurance that a specific project moves forward, it should be tied to a specific funding source. The TAC recognizes the following potential county, state, and federal funding sources that may be used (consistent with each source's guidelines/restrictions) to support this program.

1. Monitoring and Planning
   a. Safe Drinking Water Act (NYSDEC/USEPA)
   b. EOH Water Quality Investment Program Funds (Putnam/Westchester County)
   c. Watershed Environmental Assistance Program of the Water Resources Development Act (NYSDEC/US Army Corps of Engineers)
   d. Master Planning & Zoning (Department of State)
   e. Statewide Nonpoint Source (NYSDEC)
   f. MS4 Phase II Stormwater Permit Implementation (NYSDEC)
2. Construction
   a. EOH Water Quality Investment Program Funds (Putnam/Westchester County)
   b. Watershed Environmental Assistance Program of the Water Resources Development Act (NYSDEC/US Army Corps of Engineers)
   c. Statewide Nonpoint Source (NYSDEC)
   d. MS4 Phase II Stormwater Permit Implementation (NYSDEC)

Recommendations

In accordance with Components A.7, C, and E of the Charge, the TAC recommends the following actions:

1. NYSDEC should discuss the above funding sources and their funding cycles as part of its public outreach efforts to finalize the Phase II TMDL Implementation Plan (see Charge Component A.2 and A.4 for recommended outreach schedule).

2. NYSDEC should include the above funding sources, along with a short description and funding cycle, in its Phase II TMDL Implementation Plan.

3. NYSDEC should include a specific funding source (or sources) for each action item in the Plan. For those action items that are in the planning stage or are still conceptual, a recommended potential funding source should be mentioned for each action.

4. NYSDEC should include TMDL implementation as a ranking factor in its grant programs.

Charge Component A.8

"A plan for evaluating/monitoring the effectiveness of the management practices"

Introduction

An effective evaluation/monitoring program should:

- quantify the levels of phosphorus in Croton reservoirs and lakes, and the phosphorus input to those water bodies over time,
- measure the degree of success in implementing phosphorus reduction projects in the Croton watershed,
- determine progress in meeting phosphorus reduction goals; and
- provide a technical basis for determining whether implementation priorities should be adjusted.

NYSDEC's "Interim Report - Nonpoint Source Implementation of the Phase II Phosphorus TMDLs in the New York City Watershed" begins to address the monitoring/evaluation issue. It states that a system-wide endpoint monitoring system to document improvements in water quality due to phosphorus reduction load measures is necessary. The report suggests that NYCDEP continue its ongoing reservoir monitoring and modeling efforts.

Recommendations

In accordance with Components A.8, B and E of the Charge, the TAC recommends the following actions (with corresponding timeframes, where appropriate):

1. NYCDEP should continue to conduct water quality monitoring and modeling in the Croton Reservoirs in accordance with its existing program. The monitoring program is described in NYCDEP's October 2003 Integrated Monitoring Report and includes stream, reservoir and BMP effectiveness monitoring. NYCDEP is currently developing and testing hydrothermal and water quality models in accordance with multi-year Safe Drinking Water Act (SDWA) grants.

2. A tracking system should be developed for projects being implemented that will contribute to achieving TMDLs.

    a. NYCDEP has agreed to make its tracking tool available for this use. NYCDEP should track all NYCDEP Croton projects and include non-NYCDEP projects in its tracking tool database if the information is provided. The minimum fields required for entry into the system are:

Field	Description
ProjectName*	This is a short descriptive name of the project. It should be specific enough that an unrelated project will not have an identical name. A suitable name might be a subdivision name. These names do not need to be unique; related projects (e.g. a development and the associated storm water project) may have identical names.
EntryDate	Date that you are entering information into the tracking system or spreadsheet
StartDate*	Date that CONSTRUCTION is scheduled to begin
FinishDate	Date that CONSTRUCTION completes.
ProjectType*	One of several options may be selected. They are: 1 - Storm water (e.g. storm water district, storm water detention ponds) 2 - Wastewater (e.g. sewer service area expansion, septic system repair) 3 - Road Drainage Improvement 4 - Streambank Stabilization 5 - Agricultural management (e.g. Watershed Ag. program) 6 - Open Space Preservation 7 - Upzoning 8 - New Development 9 - Street Sweeping 10 - Other
Agency*	The Agency overseeing the project. This may also be a town or county department.
FundingSource	Program funding the project
Cost	Overall project cost
Comment	Descriptive comments that may be useful in identifying the project. Other comments may also be included.
ProjectLocation*	Location of the project (see LocationType)
LocationType*	One of several options may be selected to describe data entered in ProjectLocation. They are: 1 - Hard copy map 2 - centroid coordinate (enter: x,y) 3 - list of parcel ids (enter ids as: comma separated list) 4 - street address (enter: enter number, street name, town, zipcode) 5 - GIS shapefile (enter: filename) 6 - other (enter description)

* required fields

b. NYSDEC should require that, as part of the EOH-specific Phase II Stormwater Permits annual reporting requirement, MS4s report on management practices implemented to reduce phosphorus and that MS4s provide the minimum data set necessary for tracking. NYSDEC should provide project information data to the TAC.
T*imeframe:* make part of EOH MS4 reporting requirement - June 2004
NYSDEC provides data to TAC - annually

c. NYSDEC should request that the New York State Department of Transportation (NYSDOT) provide the TAC the project information data necessary to track its projects that impact phosphorus levels.
Timeframe: make request to NYSDOT - April 2004
NYSDOT provides data to TAC - annually

d. NYSDEC should provide NYCDEP the project information data necessary to track relevant projects funded through WRDA, SDWA, 319 and Bond Act funds.
Timeframe: NYSDEC provides data to NYCDEP/TAC - annually

e. Putnam and Westchester Counties should request that localities conducting phosphorus reduction projects under the Croton Plans provide the project information data necessary to track those projects to the TAC.
Timeframe: counties request information from municipalities - April 2004
municipalities provide data to TAC - annually

f. Putnam and Westchester Counties should provide the TAC the project information data necessary to track relevant projects funded through the Water Quality Improvement Funds if they are not tracked under the Croton Plans.
Timeframe: counties provide data to TAC - annually

g. Putnam and Westchester Counties should request that localities report to the TAC the status of roadway winter treatment materials and practices.
Timeframe: counties request information from municipalities - April 2004
municipalities provide project information data to TAC - annually

h. Other local projects.

3. Results of research on the effectiveness of management practices (including watershed-specific research) should be provided to the TAC and periodically reviewed.

a. Results of research on the effectiveness of management practices that has been conducted in the New York City watershed should be reported to the TAC by the appropriate TAC member.
Timeframe: annually

b. The TAC should review current literature for updated information on the effectiveness of management practices.
Timeframe: annually

c. The TAC should discuss the results of (a) and (b), above, and make recommendations for modifications to management practices to parties responsible for implementation.
Timeframe: at least every two years

4. The TAC should periodically review all relevant information (e.g., water quality data, implementation status, research results) and recommend adjustments to NYSDEC's Phase II TMDL Implementation Plan. The TAC's approach should be comprehensive and technically oriented.

a. Project implementation information (in spreadsheet format per tracking database) should be compiled and distributed by the appropriate TAC member to all TAC members.
Timeframe: periodically - no less than annually

b. NYCDEP should provide the Bureau of Water Supply Annual Report to all TAC members.
Timeframe: annually

c. The TAC should meet and review project implementation status and NYCDEP's annual water quality report to:
i. review progress toward meeting Implementation Plan milestones,
ii. determine impediments to progress, and
iii. determine if program changes are warranted.
Timeframe: quarterly

d. The TAC should provide a progress report to NYSDEC and Croton watershed counties/municipalities on meeting the goals stated above.
Timeframe: every two years

f. The TAC should periodically reach out to regional stakeholders for the purposes of information dissemination and feedback.

Timeframe: to be determined through Phase II TMDL Implementation Plan

5. NYSDEC should consider updating its Phase II TMDL Implementation Plan as needed based on input from the TAC and other sources and to reflect progress being made in Plan implementation.

Appendix A.

Proposed TMDL Phosphorus Reductions Calculations

Introduction

The Phase II TMDLs include a total phosphorus reduction required for each reservoir basin to come into compliance with its individual TMDL. This report provides two different scenarios for distributing the phosphorus reductions between the reservoir basins and the watershed towns.

> Scenario #1 – calculate in-basin and upstream reductions for all reservoirs and allocate these reductions to the municipalities according to the guidelines developed by the TAC.
>
> Scenario #2 – identical to Scenario #1 except with lower Wasteload Allocations for the wastewater treatment plants.

The TAC determined certain guidelines for allocating phosphorus load reductions in the Croton System. The basic guidelines are:

- Utilize the same information developed for the PhII TMDL analyses.
- Assign load reductions to municipalities proportional to their existing loads as determined through the watershed modeling.
- Maximize the load reduction allocated to the individual reservoir basin before allocating reductions upstream but assume each reservoir basin can achieve reductions of no more than 40% of their existing nonpoint source load from in-basin sources. Any additional reductions must be obtained from upstream sources.
- Recalculate the reduction due to compliance of upstream reservoirs to fully account for anticipated phosphorus retention within the upstream reservoirs.
- Exclude the West Branch and Bog Brook reservoirs from the analysis. These basins are in compliance with their TMDLs and the phosphorus load transmitted downstream from the West Branch Reservoir is not controlled by watershed sources.
- Exclude Connecticut from the allocations.
- Defer complete compliance for Diverting Reservoir and only assume a 40% reduction of in-basin nonpoint sources and reductions due to upstream compliance of East Branch Reservoir.

It must be remembered that all of the load calculations are estimates and should be used in a relative sense. The values presented here are useful for planning purposes and show the relative reductions that are required by basin and by town. However, nonpoint source loads vary tremendously from year to year and the model that these calculations are based on is a simple model and can not account for all sources of phosphorus.

Allocation Scenarios
Basic Information

The reservoir and watershed data utilized in these calculations are from the PhII TMDL analyses. Table 1 provides the basic PhII TMDL Information for each of the reservoirs.

Guidance Value: the in-reservoir phosphorus concentration (total P) target. The guidance value for source water reservoirs is 15 ug/l; the guidance value for non-source water reservoirs is 20 ug/l.

TMDL: the phosphorus load that will achieve the specified guidance value as a geometric mean phosphorus concentration during the reservoir growing season.

Margin of Safety (MOS): varies between 10% and 20% of the TMDL depending on the variability of the reservoir phosphorus concentrations during the five year period used to determine the TMDL.

Available Load: equal to the TMDL minus the MOS. It represents the phosphorus load available for allocation between point and nonpoint sources within the basin.

Wasteload Allocation (WLA): the portion of the TMDL allocated to point sources. Each wastewater treatment plant (WWTP) in the watershed is assigned a fixed daily phosphorus load based on the permitted flow and phosphorus effluent concentrations contained in the plant's SPDES permit.

Load Allocation (LA): the portion of the TMDL allocated to nonpoint sources. It is equal to the remaining load in the TMDL after the MOS and WLA are accounted for.

Current Load: calculated from monitored phosphorus concentrations in the reservoir for the same five year period as the TMDL.

Total Reductions Required: calculated by subtracting the Available Load from the Current Load.

Table 1. PhII TMDL Information.

	Guidance Value (ug/l)	**TMDL (kg/yr)**	**MOS (kg/yr)**	**Available Load (kg/yr)**	**WLA (kg/yr)**	**LA (kg/yr)**	**Current Load (kg/yr)**	**Total Reductions Required (kg/yr)**
East Branch	20	2822	353	2469	449	2020	3462	993
Bog Brook	20	375	38	337	28	309	321	0
Diverting	20	2798	406	2392	232	2160	3844	1452
Middle Branch	20	949	133	816	173	643	1020	204
Croton Falls	15	3565	535	3030	615	2415	5010	1980
Amawalk	20	1329	133	1196	390	806	1318	122
Cross River	15	1007	126	881	107	774	717	57
Titicus	20	1158	174	984	0	984	1124	140
Muscoot	20	9397	940	8457	1405	7052	11560	3103
New Croton	15	9731	973	8758	209	8549	11189	2431

Note: MOS = Margin of Safety; WLA = Wasteload Allocation; LA = Load Allocation; Current Load is estimated from the reservoir concentrations during the five year period used in the PhII TMDL calculations; Total Reductions Required = Current Load – Available Load.

The PhII TMDL analysis also included modeling of the phosphorus sources within the watershed. Some of this modeling information is necessary in order to allocate reductions and is provided in Table 2. Unless noted, all values are an average of the four years modeled (1993-1996).

Current Reservoir Concentration: concentration used to estimate the Current Load to the reservoir (given in Table 1).

Current Outflow Concentration: average concentration from the monitoring site closest to the outflow of the reservoir (generally at the dam). Note that the outflow concentration is often less than the reservoir concentration. This is because of retention of phosphorus within the reservoir itself.

Current Outflow Load: the phosphorus load leaving the reservoir through the spill and release works, it is calculated from the outflow volume and concentration.

In-basin NPS Load: modeled nonpoint source load to each reservoir from its own watershed.

Subbasin Load: modeled load from selected subbasins within the reservoir basin. Large lakes within the Croton System (surface area greater than 40 ha) were treated as separate subbasins in the watershed model.

Upstream Reservoir Load: estimated load from upstream reservoirs (see Current Outflow Load too).

In-basin WWTP Load: estimated load from WWTPs within the reservoir basin.

Table 2. Additional Reservoir Information.

	Current Reservoir Conc. (ug/l)	**Current Outflow Conc. (ug/l)**	**Current Outflow Load (kg/yr)**	**In-basin NPS Load (kg/yr)**	**Subbasin Load (kg/yr)**	**Upstream Reservoir Load (kg/yr)**	**In-basin WWTP Load (kg/yr)**
East Branch	24.5	24.5	2008	2734	189	0	329
Bog Brook	17.1	17.6	141	187	68	0	5
Diverting	27.5	26.1	2420	606	0	2618	371
Middle Branch	21.5	23.7	580	371	528	0	113
Croton Falls	21.1	13.7	1061	779	0	1083	2048
Amawalk	19.8	14.8	349	808	170	0	381
Cross River	10.7	12.6	543	926	84	0	64
Titicus	19.4	18.4	577	1017	0	0	0
Muscoot	24.6	22.5	9108	4335	0	5579	1852
New Croton	17.2	na	na	3019	0	9108	343

Note: “Current” refers to the 4 year average concentration or load used in the PhII TMDL modeling analyses.

As stated before, the Total Reductions Required for each reservoir to meet its TMDL is calculated by subtracting the Available Load from the Current Load. These reductions are then distributed between point and nonpoint sources for scenarios #1 and #2 (Table 3). The phosphorus reductions allocated to each reservoir basin are provided in Table 4.

In the PhII TMDL analyses, the planned WWTP upgrade program was taken into account by comparing the 1996 loads from the WWTPs to their WLAs. If the WWTP load exceeded the WLA then the difference was applied as a “credit”. In many cases, the WWTP load was below the WLA because the plant was not operating at full capacity and no “credit” for the upgrade program was included.

The PhII TMDL analyses also estimated a reduction from upstream once the upstream reservoirs were in compliance with their own TMDLs. The Current Outflow Concentration was compared to the applicable guidance value. If the Current Outflow Concentration was above the guidance value then the difference (calculated as a load) was applied as a “credit”. This method provided a conservative estimate of the expected load reduction due to upstream compliance with the TMDLs because it does not take into account retention within the reservoir. The PhII Nonpoint Reduction was calculated by subtracting the PhII WWTP Reduction and the PhII Upstream Reduction from the Total Reductions Required. The PhII Nonpoint Reduction was assigned to each reservoir without determining how much could be achieved within the basin and how much would be needed from upstream sources.

Therefore, the Total Reductions Required is composed of the following:

Total		PhII		PhII		PhII
Reductions	=	WWTP	+	Upstream	+	NPS
Required		Reduction		Reduction		Reduction

The PhII NPS Reduction was backcalculated from the other three values as:

PhII		Total		PhII		PhII
NPS	=	Reduction	–	WWTP	–	Upstream
Reduction		s Required		Reduction		Reduction

The new analysis provided here recalculates the effects of upstream compliance with the TMDLs and explicitly incorporates retention of phosphorus in the upstream reservoirs. Therefore, in Scenario #1, the NPS Reduction for each reservoir is recalculated to only take into account the original WWTP Reduction.

Total		PhII		Scenario #1
Reductions	=	WWTP	+	NPS
Required		Reduction		Reduction

In Scenario #2, the WLAs are reduced which results in a greater “credit” due to the upgrade program. This is added to the original PhII WWTP Reduction.

Total		PhII		Scenario #2		Scenario #2
Reductions	=	WWTP	+	WWTP	+	NPS
Required		Reduction		Reduction		Reduction

Table 3. Phosphorus Reductions.

	Total Reductions Required (kg/yr)	PhII WWTP Reduction (kg/yr)	PhII Upstream Reduction (kg/yr)	PhII NPS Reduction (kg/yr)	Scenario #1 NPS Reduction (kg/yr)	Scenario #2 WWTP Reduction (kg/yr)	Scenario #2 NPS Reduction (kg/yr)
East Branch	993	0	0	993	993	256	737
Bog Brook	0	0	0	0	0	19	0
Diverting	1452	0	469	983	1452	39	1413
Middle Branch	204	0	0	204	204	92	112
Croton Falls	1980	1095	0	885	885	183	702
Amawalk	122	0	0	122	122	189	0
Cross River	57	0	0	57	57	50	7
Titicus	140	0	0	140	140	0	140
Muscoot	3103	226	819	2058	2877	427	2450
New Croton	2431	0	1075	1356	2431	110	2321

Table 4. In-Basin Reductions per Scenario.

	SCENARIO #1			SCENARIO #2		
	Total In-basin reduction (kg/yr)	Existing NPS Load (kg/yr)	% Reduction Existing NPS Load	Total In-basin reduction (kg/yr)	Existing NPS Load (kg/yr)	% Reduction Existing NPS Load
East Branch	993	2923	34%	737	2923	25%
Bog Brook	0	255	0%	0	255	0%
Diverting	243	606	40%	243	606	40%
Middle Branch	585	900	65%	230	900	26%
Croton Falls	312	779	40%	312	779	40%
Amawalk	122	978	12%	0	978	0%
Cross River	163	1010	16%	0	1010	0%
Titicus	140	1017	14%	140	1017	14%
Muscoot	1734	4335	40%	1734	4335	40%
New Croton	0	3019	0%	0	3019	0%

Town Allocations

In addition to allocating phosphorus load reductions to each of the reservoir basins, the reductions have also been allocated to each town within the reservoir basin. The distribution of phosphorus reductions to each town is proportional to the phosphorus load contributed by each town based on the same watershed model used for the PhII TMDL analyses. Therefore, a town that contributes more of a nonpoint source phosphorus load to the reservoir due to its land use characteristics is allocated a greater portion of the NPS Reduction. The percentage of the phosphorus loading to the reservoir for each town is provided in Table 5.

Table 5. Percent Load Contributions by Town.

	Total NPS Load	East Branch	Bog Brook	Diverting	Middle Branch	Croton Falls	Amawalk	Cross River	Titicus	Muscoot	New Croton
Bedford	1800							29.7%		27.1%	11.6%
Beekman	24	0.0%			3.0%						
Carmel	1542				4.4%	85.2%	61.7%			4.7%	
Cortlandt	208										7.8%
East Fishkill	93				11.5%						
Kent	430	0.5%			44.6%	7.4%					
Lewisboro	947							60.4%	5.5%	6.8%	
Mount Kisco	392										14.6%
New Castle	799										29.8%
North Castle	6										0.2%
North Salem	1061	2.6%						0.3%	94.5%	8.1%	
Patterson	1044	36.5%	11.7%	0.5%	8.5%						
Pawling	721	26.8%			2.7%						
Pound Ridge	193							9.6%		2.2%	
Putnam Valley	39						3.6%				
Somers	1570					2.3%	34.7%			24.9%	3.2%
Southeast	2109	33.6%	88.3%	99.5%	25.3%	5.2%				5.4%	
Yorktown	1789									20.8%	32.7%

Notes:

-“Total NPS Load” is the modeled load for that portion of each municipality in the Watershed.

-All columns add to 100%.

Scenario Methodology

The step-by-step calculations for each scenario are presented in the following section. The steps are relatively straightforward, however, there are a few points that need to be discussed. All loads are kg/yr, and all concentrations are ug/l, total P.

Conversion of phosphorus load and phosphorus concentration

The phosphorus load from the watershed can be converted to an in-reservoir phosphorus concentration using the Vollenweider equation (see the Phase II TMDL Methodology for a more detailed discussion). The Vollenweider equation requires several reservoir characteristics such as mean depth, residence time and surface area. These values are the same in these scenario calculations as they were for the Phase II TMDL calculations. Since the reservoir characteristics remain constant, the phosphorus load is directly proportional to the phosphorus concentration. In the scenario calculations, a ratio of the TMDL and the guidance value for each reservoir has been used to convert between load and concentration.

Calculation of the Target Reservoir Concentration

The TMDL is calculated to achieve the phosphorus guidance value in the reservoir. The TMDL, however, contains a Margin of Safety that is a percentage of the TMDL. The Target Reservoir Concentration is equal to the guidance value with the Margin of Safety subtracted, and is the predicted concentration when the load to the reservoir equals the Available Load.

Calculation of Predicted Outflow Concentration

Phosphorus concentrations generally decrease from the major tributary to the reservoir to the dam due to settling and biologic uptake. Since the outflows of the reservoirs are located at the dam, this means that the outflow concentration is often less than the whole reservoir concentration. This phenonmenon was not incorporated in the initial TMDL reduction requirements but is incorporated in the scenario calculations. It is assumed that the outflow concentration will decrease by the same amount as the whole reservoir concentration.

Scenario #1 – Nonpoint Source Load Reductions Only

The detailed calculations for Scenario #1 are presented below. It should be noted that some numbers have been rounded off for ease in presentation. A summary of the results is presented in Table 6.

Step 1: Calculate the reduction in load to Diverting Reservoir due to upstream compliance. Since Bog Brook Reservoir is already in compliance, this step only involves East Branch Reservoir.

Change in East Branch Reservoir concentration	
Current reservoir concentration	_ 24.5
Target reservoir concentration	17.5
Concentration reduction	7.0
Change in East Branch outflow concentration	
Current outflow concentration	_ 24.5
Concentration reduction	7.0
Target outflow concentration	17.5

Revised outflow load from East Branch	
Target outflow concentration	x 17.5
Ratio of current outflow load/concentration	82.06
Revised Outflow Load	1431
Change in outflow load from East Branch	
Current outflow load	_ 2008
Revised outflow load	1431
Load reduction	577
Change in outflow load to Diverting (East Branch and Bog Brook loads)	
Current outflow load to Diverting	_ 2149
Load reduction	577
Revised outflow load to Diverting	1572

Step 2: Calculate the revised concentration within Diverting Reservoir and the reduction in load to downstream reservoirs (Croton Falls and Muscoot).

In-basin load reduction for Diverting	
Modeled in-basin NPS load	x 606
Load reduction percentage	40%
In-basin load reduction	243
Total load reduction to Diverting Reservoir	
In-basin load reduction	+ 243
Upstream load reduction	577
Total load reduction	820
Reduction percentage	
Current Load	3844
Total load reduction	820
Reduction percentage	21%
Revised reservoir concentration	
Current reservoir concentration	x 27.5
Reduction percentage	21%
Revised reservoir concentration	21.6
Change in reservoir concentration for Diverting	
Current reservoir concentration	_ 27.5
Revised reservoir concentration	21.6
Change in reservoir concentration	5.9
Change in outflow concentration for Diverting	
Current outflow concentration	_ 26.1
Change in concentration	5.9
Revised outflow concentration	20.2
Change in outflow load downstream	
Current outflow load	_ 2420
Revised outflow load	1875
Outflow load reduction	545

(Note that the Diverting Reservoir outflow goes to both Croton Falls and Muscoot. Half of the load reduction will be attributed to each reservoir)

Step 3: Calculate the load reduction from compliance in Middle Branch Reservoir

Change in Middle Branch Reservoir concentration	
Current reservoir concentration	− 21.5
Target reservoir concentration	17.2
Concentration reduction	4.3
Change in Middle Branch outflow concentration	
Current outflow concentration	− 23.7
Concentration reduction	4.3
Target outflow concentration	19.4
Revised outflow load from Middle Branch	
Target outflow concentration	x 19.4
Ratio of current outflow load/concentration	24.46
Revised Outflow Load	475
Change in outflow load to Croton Falls	
Current outflow load	− 580
Revised outflow load	475
Outflow load reduction	105

Step 4: Calculate the load reductions to Croton Falls due to in-basin and upstream reductions

In-basin load reduction for Croton Falls	
Modeled in-basin NPS load	x 779
Load reduction percentage	40%
In-basin load reduction	312
Total load reduction to Croton Falls	
In-basin load reduction	+ 312
Load reduction from Diverting (50% of total)	272
Load reduction from Middle Branch	105
Total load reduction with compliance	689
Additional Load reduction required	
Total NPS load reduction required	− 885
Load reduction with compliance	689
Additional reductions required	196

Since Diverting Reservoir cannot accommodate any further reductions and West Branch Reservoir concentrations isn't controlled by watershed characteristics, this additional reduction must be allocated to Middle Branch Reservoir

Step 5: Determine effect of the additional load reduction from Middle Branch Reservoir

Revised outflow load from Middle Branch Reservoir	
Target outflow load	− 475
Additional reductions required	196
Revised target outflow load	278

Change in Middle Branch outflow concentration	
Current outflow concentration	_ 23.7
Target reservoir concentration	11.4
Concentration reduction	12.3
Change in Middle Branch Reservoir concentration	
Current reservoir concentration	_ 21.5
Concentration reduction	12.3
Revised target reservoir concentration	9.2
Reduction percentage	57%
Revised watershed load reduction	
Current watershed load	x 1020
Reduction percentage	57%
Revised watershed load	435
Revised load reduction percentage	
Current in-basin NPS load	1020
Revised in-basin NPS load	435
Reduction percentage	65%

<u>Step 6</u>: Calculate the load reduction from compliance in Croton Falls Reservoir

Change in Croton Falls Reservoir concentration	
Current reservoir concentration	_ 21.1
Target reservoir concentration	12.7
Concentration reduction	8.3
Change in Croton Falls outflow concentration	
Current outflow concentration	_ 13.7
Concentration reduction	8.3
Target outflow concentration	5.3
Revised outflow load from Croton Falls	
Target outflow concentration	x 5.3
Ratio of current outflow load/concentration	77.62
Revised Outflow Load	414
Change in outflow load to Muscoot	
Current outflow load	_ 1061
Revised outflow load	414
Outflow load reduction	647

<u>Step 7</u>: Calculate the load reduction from compliance in Amawalk Reservoir

Change in Amawalk Reservoir concentration	
Current reservoir concentration	_ 19.8
Target reservoir concentration	18.0
Concentration reduction	1.8
Change in Amawalk outflow concentration	
Current outflow concentration	_ 14.8
Concentration reduction	1.8
Target outflow concentration	12.9
Revised outflow load from Amawalk	

Target outflow concentration	x 12.9
Ratio of current outflow load/concentration	23.66
Revised Outflow Load	306
Change in outflow load to Muscoot	
Current outflow load	_ 349
Revised outflow load	306
Outflow load reduction	43

Step 8: Calculate the load reduction from compliance in Titicus Reservoir

Change in Titicus Reservoir concentration	
Current reservoir concentration	_ 19.4
Target reservoir concentration	17.0
Concentration reduction	2.4
Change in Titicus outflow concentration	
Current outflow concentration	_ 18.4
Concentration reduction	2.4
Target outflow concentration	16.0
Revised outflow load from Titicus	
Target outflow concentration	x 16.0
Ratio of current outflow load/concentration	31.41
Revised Outflow Load	501
Change in outflow load to Muscoot	
Current outflow load	_ 577
Revised outflow load	501
Outflow load reduction	76

Step 9: Calculate the load reductions to Muscoot Reservoir due to in-basin and upstream reductions

In-basin load reduction for Muscoot	
Modeled NPS load	x 4335
Load reduction percentage	40%
In-basin load reduction	1734
Total load reduction to Muscoot	
In-basin load reduction	+ 1734
Load reduction from Diverting (50% of total)	+ 272
Load reduction from Croton Falls	+ 647
Load reduction from Amawalk	+ 43
Load reduction from Cross River	+ 0
Load reduction from Titicus	76
Total load reduction with compliance	2772

Additional Load reduction required	
Total NPS load reduction required	_ 2877
Load reduction with compliance	2772
Additional reductions required	104

Since Cross River Reservoir does not require any nonpoint source reductions to meet its own TMDL, and the other contributing reservoirs do, this additional reduction is allocated to Cross River.

Step 10: Determine effect of the load reduction from Cross River Reservoir

Revised outflow load from Cross River Reservoir	
Current outflow load	_ 543
Reductions required	104
Target outflow load	439
Change in Cross River outflow concentration	
Current outflow concentration	_ 10.2
Target outflow concentration	12.6
Concentration reduction	2.4
Change in Cross River Reservoir concentration	
Current reservoir concentration	_ 10.7
Concentration reduction	2.4
Revised target reservoir concentration	8.3
Reduction percentage	23%
Revised watershed load reduction	
Current watershed load	x 717
Reduction percentage	23%
Revised watershed load	554
Revised load reduction percentage	
Current watershed load	717
Revised watershed load	163
Reduction percentage	16%

Step 11: Calculate the load reductions to New Croton Reservoir due to Muscoot Reservoir compliance

Change in Muscoot Reservoir concentration	
Current reservoir concentration	_ 24.6
Target reservoir concentration	18.0
Concentration reduction	6.6
Change in Muscoot outflow concentration	
Current outflow concentration	_ 22.5
Concentration reduction	6.6
Target outflow concentration	15.9

Revised outflow load from Muscoot	
Target outflow concentration	x 15.9
Ratio of current outflow load/concentration	405.52
Revised Outflow Load	6430
Change in outflow load to New Croton	
Current outflow load	_ 9108
Revised outflow load	6430
Outflow load reduction	2678

Since New Croton Reservoir requires a Total NPS Reduction of 2478 kg/yr, no further reductions are required.

Scenario #2 – Revised WLAs

The only change in the calculations from Scenario #1 to Scenario #2, are a reduction in the Total NPS Reductions required per basin due to lower allocations to point sources. The primary effects are seen in Steps 5 and 10. A summary of the results is presented in Table 7.

Step 1: Calculate the reduction in load to Diverting Reservoir due to upstream compliance. Since Bog Brook Reservoir is already in compliance, this step only involves East Branch Reservoir.

Change in East Branch Reservoir concentration		
Current reservoir concentration	_	24.5
Target reservoir concentration		17.5
Concentration reduction		7.0
Change in East Branch outflow concentration		
Current outflow concentration	_	24.5
Concentration reduction		7.0
Target outflow concentration		17.4
Revised outflow load from East Branch		
Target outflow concentration	x	17.5
Ratio of current outflow load/concentration		82.06
Revised Outflow Load		1431
Change in outflow load from East Branch		
Current outflow load	_	2008
Revised outflow load		1431
Load reduction		577
Change in outflow load to Diverting (East Branch and Bog Brook loads)		
Current outflow load to Diverting	_	2149
Load reduction		577
Revised outflow load to Diverting		1572

Step 2: Calculate the revised concentration within Diverting Reservoir and the reduction in load to downstream reservoirs (Croton Falls and Muscoot).

In-basin load reduction for Diverting		
Modeled in-basin NPS load	x	606
Load reduction percentage		40%
In-basin load reduction		243
Total load reduction to Diverting Reservoir		
In-basin load reduction	+	243
Upstream load reduction		577
Total load reduction		820
Reduction percentage		
Current Load		3844
Total load reduction		820
Reduction percentage		21%

Revised reservoir concentration	
Current reservoir concentration	x 27.5
Reduction percentage	21%
Revised reservoir concentration	21.6

Change in reservoir concentration for Diverting	
Current reservoir concentration	_ 27.5
Revised reservoir concentration	21.6
Change in reservoir concentration	5.9

Change in outflow concentration for Diverting	
Current outflow concentration	_ 26.1
Change in concentration	5.9
Revised outflow concentration	20.2

Change in outflow load downstream	
Current outflow load	_ 2420
Revised outflow load	1875
Outflow load reduction	545

(Note that the Diverting Reservoir outflow goes to both Croton Falls and Muscoot. Half of the load reduction will be attributed to each reservoir)

Step 3: Calculate the load reduction from compliance in Middle Branch Reservoir

Change in Middle Branch Reservoir concentration	
Current reservoir concentration	_ 21.5
Target reservoir concentration	17.2
Concentration reduction	4.3

Change in Middle Branch outflow concentration	
Current outflow concentration	_ 23.7
Concentration reduction	4.3
Target outflow concentration	19.4

Revised outflow load from Middle Branch	
Target outflow concentration	x 19.4
Ratio of current outflow load/concentration	24.46
Revised Outflow Load	475

Change in outflow load to Croton Falls	
Current outflow load	_ 580
Revised outflow load	475
Outflow load reduction	105

Step 4: Calculate the load reductions to Croton Falls due to in-basin and upstream reductions

In-basin load reduction for Croton Falls	
Modeled in-basin NPS load	x 779
Load reduction percentage	40%
In-basin load reduction	312

Total load reduction to Croton Falls	
In-basin load reduction	+ 312
Load reduction from Diverting (50% of total)	272
Load reduction from Middle Branch	105
Total load reduction with compliance	689
Additional Load reduction required	
Total NPS load reduction required	_ 702
Load reduction with compliance	689
Additional reductions required	13

Since Diverting Reservoir cannot accommodate any further reductions and West Branch Reservoir concentrations isn't controlled by watershed characteristics, this additional reduction must be allocated to Middle Branch Reservoir

Step 5: Determine effect of the additional load reduction from Middle Branch Reservoir

Revised outflow load from Middle Branch Reservoir	
Target outflow load	_ 475
Additional reductions required	13
Revised target outflow load	461
Change in Middle Branch outflow concentration	
Current outflow concentration	_ 23.7
Target reservoir concentration	18.9
Concentration reduction	4.9
Change in Middle Branch Reservoir concentration	
Current reservoir concentration	_ 21.5
Concentration reduction	4.9
Revised target reservoir concentration	16.6
Reduction percentage	23%
Revised watershed load reduction	
Current watershed load	x 1020
Reduction percentage	23%
Revised watershed load	790
Revised load reduction percentage	
Current in-basin NPS load	1020
Revised in-basin NPS load	790
Reduction percentage	26%

Step 6: Calculate the load reduction from compliance in Croton Falls Reservoir

Change in Croton Falls Reservoir concentration	
Current reservoir concentration	_ 21.1
Target reservoir concentration	12.7
Concentration reduction	8.3
Change in Croton Falls outflow concentration	
Current outflow concentration	_ 13.7
Concentration reduction	8.3
Target outflow concentration	5.3
Revised outflow load from Croton Falls	

Target outflow concentration	x 5.3
Ratio of current outflow load/concentration	77.62
Revised Outflow Load	414
Change in outflow load to Muscoot	
Current outflow load	_ 1061
Revised outflow load	414
Outflow load reduction	647

<u>Step 7</u>: Calculate the load reduction from compliance in Amawalk Reservoir

Change in Amawalk Reservoir concentration	
Current reservoir concentration	_ 19.8
Target reservoir concentration	18.0
Concentration reduction	1.8
Change in Amawalk outflow concentration	
Current outflow concentration	_ 14.8
Concentration reduction	1.8
Target outflow concentration	12.9
Revised outflow load from Amawalk	
Target outflow concentration	x 12.9
Ratio of current outflow load/concentration	23.66
Revised Outflow Load	306
Change in outflow load to Muscoot	
Current outflow load	_ 349
Revised outflow load	306
Outflow load reduction	43

<u>Step 8</u>: Calculate the load reduction from compliance in Titicus Reservoir

Change in Titicus Reservoir concentration	
Current reservoir concentration	_ 19.4
Target reservoir concentration	17.0
Concentration reduction	2.4
Change in Titicus outflow concentration	
Current outflow concentration	_ 18.4
Concentration reduction	2.4
Target outflow concentration	16.0
Revised outflow load from Titicus	
Target outflow concentration	x 16.0
Ratio of current outflow load/concentration	31.41
Revised Outflow Load	501
Change in outflow load to Muscoot	
Current outflow load	_ 577
Revised outflow load	501
Outflow load reduction	76

<u>Step 9</u>: Calculate the load reductions to Muscoot Reservoir due to in-basin and upstream reductions

In-basin load reduction for Muscoot	
Modeled NPS load	x 4335
Load reduction percentage	40%
In-basin load reduction	1734
Total load reduction to Muscoot	
In-basin load reduction	+ 1734
Load reduction from Diverting (50% of total)	+ 272
Load reduction from Croton Falls	+ 647
Load reduction from Amawalk	+ 43
Load reduction from Cross River	+ 0
Load reduction from Titicus	76
Total load reduction with compliance	2772

Since Muscoot Reservoir requires a Total NPS Reduction of 2450 kg/yr, no further reductions are required.

Step 10: Not required for Scenario #2

Step 11: Calculate the load reductions to New Croton Reservoir due to Muscoot Reservoir compliance

Change in Muscoot Reservoir concentration	
Current reservoir concentration	_ 24.6
Target reservoir concentration	18.0
Concentration reduction	6.6
Change in Muscoot outflow concentration	
Current outflow concentration	_ 22.5
Concentration reduction	6.6
Target outflow concentration	15.9
Revised outflow load from Muscoot	
Target outflow concentration	x 15.9
Ratio of current outflow load/concentration	405.52
Revised Outflow Load	6430
Change in outflow load to New Croton	
Current outflow load	_ 9108
Revised outflow load	6430
Outflow load reduction	2678

Since New Croton Reservoir requires a Total NPS Reduction of 2321 kg/yr, no further reductions are required.

Table 6. Scenario #1 Phosphorus Load Reductions by Reservoir Basin.

	Total load reduction (kg/yr)	Total WWTP reduction (kg/yr)	Total NPS reduction (kg/yr)	Upstream compliance (kg/yr)	In-basin NPS Reduction: Basin TMDL (kg/yr)	In-basin NPS Reduction: Downstream compliance (kg/yr)	In-basin NPS Reduction: Total In-basin (kg/yr)	In-basin NPS Reduction: % of Existing NPS load (kg/yr)	Reduction allocated upstream (kg/yr)
East Branch	993	0	993	0	993	0	993	34%	0
Bog Brook	0	0	0	0	0	0	0	0%	0
Diverting	1452	0	1452	577	243	0	243	40%	0
Middle Branch	204	0	204	0	204	381	585	65%	0
Croton Falls	1980	1095	885	377	312	0	312	40%	196
Amawalk	122	0	122	0	122	0	122	12%	0
Cross River	57	0	57	0	0	163	163	16%	0
Titicus	140	0	140	0	140	0	140	14%	0
Muscoot	3103	226	2877	1038	1734	0	1734	40%	104
New Croton	2431	0	2431	2678	0	0	0	0%	0

Table 7. Scenario #2 Phosphorus Load Reductions by Reservoir Basin.

	Total load reduction (kg/yr)	Total WWTP reduction (kg/yr)	Total NPS reduction (kg/yr)	Upstream compliance (kg/yr)	In-basin NPS Reduction: Basin TMDL (kg/yr)	In-basin NPS Reduction: Downstream compliance (kg/yr)	In-basin NPS Reduction: Total In-basin (kg/yr)	In-basin NPS Reduction: % of Existing NPS load (kg/yr)	Reduction allocated upstream (kg/yr)
East Branch	993	256	737	0	737	0	737	25%	0
Bog Brook	0	19	0	0	0	0	0	0%	0
Diverting	1452	39	1413	577	243	0	243	40%	0
Middle Branch	204	92	112	0	112	118	230	26%	0
Croton Falls	1980	1278	702	377	312	0	312	40%	13
Amawalk	122	189	0	0	0	0	0	0%	0
Cross River	57	50	7	0	0	0	0	0%	0
Titicus	140	0	140	0	140	0	140	14%	0
Muscoot	3103	653	2450	1038	1734	0	1734	40%	0
New Croton	2431	110	2321	2678	0	0	0	0%	0