REDUCING HARMFUL PHOSPHORUS POLLUTION IN THE NEW YORK CITY RESERVOIRS THROUGH THE CLEAN WATER ACT'S "TOTAL MAXIMUM DAILY LOAD" REQUIREMENTS:

A CASE-STUDY OF THE NEW CROTON RESERVOIR AND RECOMMENDATION TO EPA

EXECUTIVE SUMMARY

This Report provides a case-study for the United States Environmental Protection Agency ("EPA") as it works to identify an appropriate water quality guidance value, and resultant Total Maximum Daily Load ("TMDL"), to control phosphorus pollution within New York City drinking water reservoirs. The TMDL "Phase II" regulatory process currently underway is a major component of the program to improve drinking water quality specified by both the Clean Water Act and the 1997 New York City Watershed Memorandum of Agreement. The TMDL process is undertaken when other pollution controls mandated by the Clean Water Act are not sufficiently effective in removing pollution that is degrading water quality.

We recommend that EPA adopt a water quality value for phosphorus that is no higher than 15 micrograms per liter ("ug/L"), or parts per billion, for all "source water" reservoirs[1] within the New York City Watershed ("Watershed"). This water quality criterion, if adopted by EPA, would represent a full 25% reduction from the earlier "Phase I" TMDL guidance value of 20 ug/L for phosphorus in these reservoirs.

We base this recommendation in part on a case-study of the condition of the New Croton reservoir in Westchester County, as well as our review of other information requested from the New York City Department of Environmental Protection ("DEP"). The New Croton's condition demonstrates the need both to reduce phosphorus pollution in reservoirs that are currently overloaded with phosphorus, and to limit future water degradation from new sources of phosphorus in reservoir basins that are currently only moderately impacted. EPA's adoption of a 15 ug/L phosphorus criterion would drive numerous efforts to reduce and limit phosphorus.

The New Croton Reservoir provides drinking water to approximately 10% to 12% of the individuals served by the New York City water supply system, or about 900,000 persons daily. Under drought conditions (and drought response planning), this reservoir may serve as the source of upwards of 25% of the City's water. The New Croton reservoir currently suffers from many serious phosphorus-triggered water quality problems (frequently termed "use impairments") even though its growing season phosphorus levels have been averaging approximately 17.2 ug/L each year. Given the problematic condition of the New Croton, it is clear that the higher 20 ug/L

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[1] A "source water" reservoir is one that may serve as the last stop for water in the New York City reservoir system before the water is chlorinated and distributed for use. The source water reservoirs within the New York City system are the Ashokan, Cross River, Croton Falls, Kensico, New Croton, Rondout and West Branch. Maps of the Watershed follow the Executive Summary.

phosphorus guidance value employed by EPA in the earlier Phase I TMDL program will not accomplish the Clean Water Act's goal -- removal of pollution and protection from further degradation.

The adverse impact of excessive phosphorus on the water quality of the New Croton Reservoir serves as an example for the entire Watershed. Each year during the summer and fall, phosphorus in the New Croton sets off a biological chain reaction. It promotes algae blooms that result in poor water taste, odor and color. Phosphorus-induced algae blooms also reduce dissolved oxygen in the bottom waters (due to increased bacteria ingesting dead algae), cause increased levels of the heavy metal pollutants iron and manganese, and increase levels of organic carbon. The chlorine-based disinfection of waters that are high in organic carbons results in the formation of chemicals that are suspected of having a number of serious adverse health impacts.

These water quality problems at the New Croton have created an "operational nightmare" for DEP. As water quality degrades each summer (with a corresponding increase in customer complaints), DEP has to shut down the flow from the New Croton or blend New Croton waters with higher quality waters from the Catskills to dilute the pollutants. These reservoir shut downs often occur for months at a time. Such actions by DEP support a finding that the New Croton water quality often does not meet its New York State classification and best use as a source of drinking water. This problem, if unaddressed, could significantly worsen under drought conditions, flooding scenarios, operational failures in other portions of the water supply system, or increased demand for water in the New York metropolitan area over time.

All seven source water reservoirs, from both the Catskill/Delaware and Croton portion of the Watershed, presently serve as a source of *unfiltered* drinking water. We recommend that no regulatory distinction be drawn between any of these water bodies simply because Croton waters are set to be chemically filtered by 2007. Rather, a 15 ug/L phosphorus TMDL for all source water reservoirs would be consistent with the well-known "multiple barrier" approach to the protection of drinking water, whether or not filtration ultimately occurs. As discussed in the National Research Council's report on the New York City Watershed, public health literature, and EPA assessments, the multiple barrier approach to water supply protection -- involving full water supply protection at the source of the water -- is superior to relying on filtration alone. The nine million people who obtain their drinking water from the Watershed deserve nothing less.

A more permissive phosphorus limit based on future chemical filtration would constitute an unprecedented rejection of the multiple barrier approach to drinking water protection. A Watershed-wide 15 ug/L phosphorus limit for all source waters is a far more appropriate, and legally defensible, criterion for the EPA's TMDL program and would yield significant water quality benefits. Moreover, this limit itself may be subject to further revision as a result of detailed scientific investigation and site specific assessments associated with the future "Phase III" TMDL review.

I. Phosphorus and the New York City Reservoir System

A. Overview of Problems Associated with Phosphorus Pollution

Phosphorus pollution is a serious threat to the purity of the New York City drinking water supply. Within a reservoir a complex ecosystem exists, including plants, microorganisms, and fish, which rely on nutrients from upstream sources. The relationship among these various organisms is tightly interconnected, but ultimately, the growth of organisms within a reservoir is directly related to the amount of nutrients flowing into the water body. The "limiting nutrient" in the New York City Watershed reservoirs is phosphorus which, if allowed to increase, would generally allow a corresponding increase in biological life (especially, plant life) in these water bodies during the warm weather growing season.[2] In other words, phosphorus levels control the extent to which plant life can grow in the New York City reservoirs.[3]

The Croton portion of the New York City Watershed, which extends through portions of Westchester, Putnam and Dutchess Counties and ultimately drains into the New Croton reservoir, has a relatively high loading of phosphorus.[4] Excessive phosphorus levels result in "eutrophic"

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[2] National Research Council, Watershed Management For Potable Water Supply: Assessing New York City's Approach at 5, 123 (1999 Prepublication Copy) (hereafter "NRC Watershed Report"). This peer-reviewed book was prepared by a working group of the National Research Council, whose members were selected for their special expertise and drawn from the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine. The report exhaustively reviews the New York City Watershed program and the applicable scientific literature.

[3] DEP, "Development of a water quality guidance value for Phase II Total Maximum Daily Loads (TMDLs) in the New York City Reservoirs" (March 1999) at 1, 7 (hereafter "DEP Report"). See also, U.S. EPA and U.S. Department of Agriculture, "Clean Water Action Plan" (Feb. 14, 1998) at 56 ("Excessive nutrient loadings will . . . result in excessive growth of macrophytes or phytoplankton and potentially harmful algal blooms . . ., leading to oxygen declines, imbalance of aquatic species, public health risks, and a general decline of the aquatic resource.").

[4] Of the 19 reservoirs in the Watershed, 10 have been technically classified as eutrophic under generally accepted assessment methodology employed by DEP. The Cannonsville reservoir is the only eutrophic water body in the Catskill/Delaware portion of the Watershed, while 9 of the 10 reservoirs within the Croton portion of the Watershed have been classified as eutrophic based on data collected by DEP since 1988. DEP Report at 1, 3. The New York State Department of Environmental Conservation ("State DEC") has listed all reservoirs within the Watershed as "stressed," "threatened" or "impaired" by phosphorus on State DEC's 1998 list of impaired water bodies prepared pursuant to Clean Water Act § 303(d) and submitted to EPA. See 33 U.S.C. § 1313(d); State DEC Division of Water, "New York State 1998 § 303(d) List" (April 1, 1998),

conditions, characterized by algae blooms and limited water transparency in the warmer weather.[5]

Algae problems arise when high quantities (loads) of phosphorus are flushed into the reservoirs from upstream and upland sources such as wastewater treatment plants, agricultural run-off, animal waste, stormwater run-off from streets and parking lots, construction sites, lawn fertilizers, golf course turf treatments, flow from streams and forests, and poorly functioning septic systems.[6] Some of these sources of phosphorus are entirely natural and are an unavoidable part of the ecosystem chemistry itself. However, a large portion of the phosphorus loading to the reservoirs is from man-made or man-altered sources. This portion of the phosphorus load is controllable and, with the proper management techniques, the levels of phosphorus in a reservoir can be significantly reduced.

When high loads of phosphorus are introduced into a reservoir impacts are not immediately apparent. However, over the course of a few days or weeks, if the high levels continue and are not flushed from the system, the phosphorus results in rapid growth of algae -- in particular, blue-green algae or cyanobacteria. A visual cue to this response is that the water becomes green in color, and mats of colored plant and bacterial life will appear on the surface, particularly in areas of stagnant water. This rapid plant growth is called an "algae bloom" and will continue until the phosphorus loading is fully consumed.

Over time, the individual algae die off, and while the bloom itself continues in the surface waters, the dead algae will fall to the bottom of the reservoir's water column. As it descends, the dead plant material is consumed by an expanding population of bacteria and other animal life. A rapid decline in the levels of dissolved oxygen in the water ensues because the increased population of bacteria that consume the dead algae also consume oxygen as they respire, or breathe. As the levels of oxygen decrease, the water may become almost completely deprived of dissolved oxygen, and an anaerobic (without oxygen) condition will result. Other forms of life will live in this anaerobic environment, such as bacteria, but almost all fish cannot. The fish living there will move elsewhere, or die.

This anaerobic environment causes serious problems when the water is to be used as a drinking water supply. Generally, drinking water is drawn from the bottom of a reservoir, since this water will less likely contain algae. While this practice can avoid the algal mats, it is more likely to draw the anaerobic (low oxygen) water that results from an algal bloom. Anaerobic water contains bacteria that generate serious odor and taste problems as well as poor water color. In addition, anaerobic conditions cause contaminants such as iron, manganese, hydrogen sulfide and even additional phosphorus to be released from reservoir bottom sediments into the water,

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attachment A, at 17-18.

[5] NRC Watershed Report at 79.

[6] NRC Watershed Report at 124.

further deteriorating the quality of the water.[7]

Eutrophic water conditions triggered by excess phosphorus also result in increased levels of organic carbon in the water.[8] As in most other drinking water supply systems, chlorine is used to disinfect water from New York City reservoirs prior to distribution to consumers. The chlorine-based disinfection of waters that are high in organic carbon results in the formation of a class of chemicals known as "disinfection byproducts" -- chemicals that are suspected of being carcinogenic and of increasing the risk of early term miscarriages.[9]

High levels of phosphorus also encourage the rapid growth of "blue-green" algae (cyanobacteria). This group of organisms, which contributes significantly to taste and odor problems, presents an even more serious problem than other forms of algae because blue-green algae also produce toxins which, at high levels, pose a concern for human and animal health. It should be noted, however, that before significant levels of blue-green algae are present in a reservoir, the use of that water body as a water supply is suspended to minimize risks.[10] Thus, if an algae bloom persists, DEP is forced to switch to alternative water sources due to the cumulative negative impacts of eutrophic conditions. This is a frequent occurance with the New Croton reservoir.

B. Phosphorus Pollution in the New Croton Reservoir

The New Croton Reservoir has been used for water supply purposes since 1842, when the Old Croton Aqueduct was constructed. The 1906 New Croton dam created the existing reservoir, which has a drainage basin encompassing the entire Croton portion of the Watershed, some 375 square miles in all. The reservoir itself is located in northwestern Westchester County within the towns of Yorktown, Cortlandt, Somers, New Castle, North Castle, and Bedford. The immediate upland basin is primarily forested, but 14% of the area surrounding the reservoir is classified as urban. Most of the water (approximately 82%) entering the New Croton flows from

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[7] NRC Watershed Report at 123; DEP Report at 7.

[8] NRC Watershed Report at 79.

[9] NRC Watershed Report at 2, 5-6, 76-77, 123. According to EPA, certain disinfection byproducts have been shown to be carcinogenic in animal studies. Others have caused adverse reproductive or developmental effects in laboratory animals. EPA also cited a study that suggested an association between early term miscarriage and exposure to drinking water with elevated levels of the disinfection byproduct trihalomethane. 63 Fed. Reg. 69389, 69394 (Dec. 16, 1998) ("Disinfectants and Disinfection Byproducts; Final Rule").

[10] DEP Report at 8 to 9. The NRC Watershed Report at pages 79 and 123 provides a general description of the adverse impacts of phosphorus-induced eutrophication of drinking water supplies.

an upstream chain of reservoirs rather than from immediate upland sources.[11]

The New Croton Reservoir is the "terminal" reservoir for the Croton portion of the Watershed, as all the water supplied by the Croton portion of the Watershed is collected in the New Croton Reservoir before entering the distribution system. Typically, the Croton System supplies about 10% to 12% of the water used by consumers of the New York City water supply. However, in extreme situations such as droughts, this system can supply upwards of 25% of the total.[12]

Typically, the concentration of phosphorus within the New Croton Reservoir ranges between 16 and 18 ug/L during the growing season, with the average phosphorus levels for 1992 through 1996 being 17.2 ug/L for the entire reservoir.[13] This phosphorus concentration is already significantly below the 20 ug/L phosphorus criterion that was employed by EPA in the previous "Phase I" TMDL process. Despite having a lower phosphorus concentration than the previously employed guidance value, the New Croton still suffers from algae blooms, anoxia (low dissolved oxygen), poor taste, increased color and other problems associated with serious eutrophication -- requiring the reservoir's use to be limited or suspended during significant portions of the growing season.[14]

For example, during the six year period from 1990 through 1995, the New Croton reservoir had a minimum of 54 "algal events"[15] which resulted in the reservoir being shut down for an average of 16% of the time; several of the suspensions lasted as long as 4 months.[16] During this 6-year period, the reservoir aquaduct was closed off 11 separate times, for a total of 299

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[11] Hazen and Sawyer, *et al.*, "The New York City Water Supply System" (January 1997) at 2. DEP, "Proposed Phase II Phosphorus TMDL Calculations for New Croton Reservoir" (March 1999) (prepared by Dr. Kimberlee Kane) at 11 (hereafter "DEP New Croton Report").

[12] Id.

[13] DEP New Croton Report at 16-17. In the DEP Report at pages 30, 32, and 42 DEP identified a 20 ug/L phosphorus level in reference to the New Croton reservoir. This was the phosphorus level found in the surface waters where algae (and phosphorus) can become concentrated. The phosphorus value for the entire reservoir water column, the one generally used in the TMDL assessments, is the lower value of 17.2 ug/L.

[14] DEP Report at 22-25.

[15] DEP Report at 22.

[16] Id.

days.[17] Recently, DEP has attempted to keep the reservoir (and hence, the Croton portion of the Watershed) online by significantly reducing its flow and blending New Croton water with Catskill water. Despite these efforts, water quality impairments have continued to force DEP to completely shut down the New Croton. See Figures 5 and 6 in the Appendix for a graphical depiction of New Croton reservoir shutdowns.

Even when algae blooms induced by excessive phosphorus are not severe enough to warrant a complete shutdown of the water supply, higher than normal algae levels can nevertheless impair drinking water disinfection. Higher level of sediments and organic materials found in eutrophic waters transport microbes, which often become embedded in these materials, and operate protect the microbes from being destroyed by the chlorine disinfectant.[18]

The use of chlorine to disinfect water (*i.e.*, kill water-borne microbes) is known to result in the creation of disinfection byproducts, such as trihalomethanes and haloacetic acids, which pose risks to human health.[19] The presence of excessive algae in the water requires the DEP to use far more chlorine than would normally be necessary.[20] It is highly likely that such additional chlorine treatment increases the amount of disinfection byproducts released into the drinking water beyond levels found in non-eutropic waters.[21] The only currently known method of lessening the creation of chlorine disinfection byproducts is to reduce organic (carbon based) material in the water.[22] In the case of the New Croton, this can best be achieved by reducing the algae levels, which, in turn, requires reductions in phosphorus loadings to the reservoir.[23]

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[17] DEP has noted that during this period there was a 124 day shutdown for inspection and maintenance. However, this work was scheduled to coincide with the time period when the reservoir was anticipated to be impaired because of algae blooms.

[18] NRC Watershed Report at 15, 126.

[19] NRC Watershed Report at 2, 5-6, 76-77, 123-126. See also 63 Fed. Reg. 69389, 69394 (Dec 16. 1998) ("Disinfectants and Disinfection Byproducts; Final Rule").

[20] DEP Report at 22-23.

[21] NRC Watershed Report at 76-78; see also DEP Report at 22 and 23.

[22] NRC Watershed Report at 78.

[23] See, e.g., NRC Watershed Report at 123.

II. Total Maximum Daily Load Program for the Watershed

A. The Clean Water Act Permit Program

In 1972, after concluding that "the Federal water pollution control program . . . has been inadequate in every vital aspect, Congress enacted the [Federal Water Pollution Control Act] Amendments [also known as the Clean Water Act], declaring 'the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985.'"[24] The Clean Water Act ("the Act") established a partnership between the states and the federal Government, in order "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[25]

The Act requires the States to promulgate water quality standards to "establish the desired condition of a waterway."[26] State authorities must periodically review water quality standards and secure the EPA's approval of any revisions in the standards.[27] The "primary means" for achieving water quality standards is the National Pollutant Discharge Elimination System ("NPDES"), a permitting program administered by the States and in some cases by the Federal Government.[28] The Act generally prohibits any person from discharging pollution from any discrete conveyance or "point source" into a waterway without a NPDES permit.[29]

Permits, as written by the states or federal government, contain "effluent limitations," which "restrict the quantities, rates, and concentrations of specified substances which are discharged from point sources."[30] Under the Act, effluent limitations have generally been "technology-based," reflecting the technical and economic feasibility of eliminating pollution from discharges to waterways.[31]

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[24] EPA v. California ex rel. State Water Resources Control Board, 426 U.S. 200, 203 (1976).

[25] 33 U.S.C. § 1251(a).

[26] Arkansas v. Oklahoma, 503 U.S. 91, 101 (1992); see 33 U.S.C. § 1313(a).

[27] 33 U.S.C. § 1313(c).

[28] See Arkansas v. Oklahoma, 503 U.S. at 101; 33 U.S.C. § 1342.

[29] 33 U.S.C. § 1311(a).

[30] Arkansas v. Oklahoma, supra; see 33 U.S.C. § 1311.

[31] 33 U.S.C. § 1311(b). Effluent limitations may also be devised based upon the water quality of the receiving water, see 33 U.S.C. § 1312, but the states and federal government have generally relied instead upon technology-based standards in implementing the NPDES program.

B. The Role of TMDLs under the Clean Water Act

The Total Maximum Daily Load program is set forth in Section 303(d) of the Act, 33 U.S.C. §1313(d). TMDLs regulate waterbodies "failing to meet water quality standards even upon application of technological pollution controls."[32] The TMDL program first requires the states to identify water bodies for which the technology-based effluent limitations are insufficient and to establish "a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters."[33]

The states must forward to EPA a recommendation for a total maximum daily load for pollutants for each impaired water body, such that pollutants will be limited to "a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality."[34] Federal regulations further require that pollutant loads be subdivided into "wasteload allocations" consisting of pollution discharging into a waterbody from point sources and "load allocations" consisting of nonpoint pollution (*i.e.*, runoff) draining into the water body.[35]

The TMDL program is intended to be an ongoing mechanism to ensure that pollution loadings into a water body are reduced if necessary to ensure compliance with water quality standards.[36] EPA must approve or reject a state's proposed TMDL within 30 days of its submission; if the state's proposal is rejected, EPA must specify a TMDL for the particular water body within 30 days of rejection.[37]

Consistent with the Clean Water Act's goal of eradicating pollution by 1985, the states' initial submissions of TMDLs to EPA were due on June 26, 1979.[38]

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[32] NRDC v. Fox, 30 F.Supp.2d 369, 373 (S.D.N.Y 1998); see 33 U.S.C. § 1313(d).

[33] 33 U.S.C. § 1313(d)(1)(A). As noted previously, all 19 New York City reservoirs have been listed as "stressed," "threatened" or "impaired" due to phosphorus on State DEC's list of impaired water bodies.

[34] 33 U.S.C. § 1313(d)(1)(C).

[35] See 40 C.F.R. § 130.2(e)-(i).

[36] 33 U.S.C. § 1313(d)(2).

[37] Id.

[38] See NRDC v. Fox, 909 F.Supp. 153, 157 (S.D.N.Y. 1995).

C. Water Quality Criteria Applicable to the TMDL Process

Various water quality criteria play an important role in EPA's specification of a phosphorus guidance value for use in calculating TMDLs for the Watershed reservoirs. EPA has required TMDLs to be established at "levels required to attain the applicable narrative and numerical water quality standards" set by the states.[39]

State DEC has classified the source water reservoirs in the New York City Watershed as "Class AA" or "Class A" fresh surface waters. The basic distinction between these two classifications is that a Class AA water body is to be of sufficient quality to serve as a source of unfiltered drinking water, while a Class A water body is one that will supply safe drinking water after its water has been subjected to filtration.[40] The New Croton Reservoir is in large part classified as AA (that portion extending from the New Croton Dam to a point one mile upstream, or east, of the New Croton Gatehouse, which contains the intakes) and in part as an A water body.[41]

Various "narrative water quality standards" have been specified by State DEC which apply to the Watershed reservoirs. Of particular application to the Watershed TMDL process is the narrative standard prohibiting phosphorus "in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages."[42] Also highly relevant to phosphorus pollution and resulting eutrophication is the New York State narrative water quality standard barring "[t]aste-, color-, and odor-producing, toxic and other deleterious substances . . . in amounts that will adversely affect the taste, color or odor thereof, or impair the waters for their best usages."[43]

Expert research, analysis and scientific discretion are necessary when EPA adopts a specific *numeric* water quality criterion for phosphorus (essentially a concentration of phosphorus in the water in parts per billion or ug/L) for the Watershed's source water reservoirs based upon the State's *narrative* water quality standards. The numeric water quality guidance value is then used by EPA to calculate a specific limit on the total reservoir loading of phosphorus (the TMDL) that will improve or maintain the reservoirs as a drinking water source, with an appropriate

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[39] 40 C.F.R. § 130.7(c).

[40] See 6 NYCRR §§ 701.5, 701.6.

[41] See 6 NYCRR § 864.6 Table I, Items No. 82, 83.

[42] 6 NYCRR § 703.2.

[43] 6 NYCRR § 703.2.

"margin of safety" to account for uncertainties.[44]

Other data, policy and criteria that bear on drinking water quality also factor into EPA's effort to essentially specify a numeric interpretation of a New York State narrative water quality standard for the Watershed. For example, pursuant to the Federal Safe Drinking Water Act, 42 U.S.C. § 300f *et seq.*, and New York law, maximum contaminant levels ("MCLs") for public water systems supplied by surface water sources apply to the New York City reservoirs. While these MCLs are not, themselves, water quality standards, they provide benchmarks for assessing whether the narrative water quality standards are being attained.[45] Thus, if phosphorus pollution results in violations of MCLs, then narrative water quality standards generally are not being attained.[46]

D. EPA's Approval of Phase I TMDLs for the New York City Watershed

A phased approach to the promulgation of TMDLs for the New York City Watershed is being implemented in an effort involving EPA, State DEC, and DEP.[47]

On January 31, 1997, State DEC submitted the Phase I TMDLs for the Watershed to EPA for review. On April 2, 1997, EPA approved TMDLs for eight City reservoirs, finding that they were excessively polluted with phosphorus and would require point and/or nonpoint reductions in phosphorus. The eight reservoirs for which TMDLs were issued include seven in the Croton

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[44] See generally 40 C.F.R. Part 130 (EPA TMDL regulations).

[45] See NRDC v. Fox, 30 F.Supp. 369, 381 (S.D.N.Y. 1998); see 6 NYCRR §§ 701.5(a), 701.6(a).

[46] In this regard, the MCL for color is violated if the average of two samples from the same sampling point in a water body measures 15 or more color units. See 10 NYCRR § 5-1.52 (Table 1). The New Croton Reservoir repeatedly exceeded this MCL. Similarly, dissolved oxygen levels, a criterion closely related to phosphorus pollution, may not be less than 4 milligrams per liter (mg/L), 5 mg/L for trout waters, and 7 mg/L for cold waters suitable for trout spawning. 6 NYCRR § 703.3.

[47] Beyond the statutory requirements, the 1997 New York City Watershed Memorandum of Agreement ("MOA") discusses the Watershed phosphorus TMDL process at length. See MOA ¶ 162. DEP met its MOA obligation to prepare its recommendations for the Phase II TMDL process by March 1999. The MOA then called upon State DEC to submit recommended Phase II TMDLs to EPA by October of 1999. EPA was then obligated to approve or disapprove the TMDLs within 30 days. MOA ¶ 162(e) and (f); 33 U.S.C. § 1313(d)(2). Importantly, after adoption of the TMDLs the MOA requires DEP and State DEC to "identify, evaluate and develop potential management practices for controlling nonpoint source pollution which, if implemented, would provide reasonable assurances" that the TMDLs will be attained. MOA ¶ 162(g).

portion of the Watershed (Bog Brook, East Branch, Middle Branch, Croton Falls, Diverting, Muscoot, and New Croton) and the Cannonsville Reservoir in the Catskill and Delaware portion of the Watershed ("Catskill/Delaware system"). EPA found that TMDLs for ten other City reservoirs were "submitted by NYSDEC for information purposes only, pursuant to § 303(d)(3) of the Clean Water Act" because "critical loads [for phosphorus] are not exceeded" in these water bodies.[48]

In making this Phase I determination, EPA calculated the TMDLs for phosphorus loads in the reservoirs employing a phosphorus guidance value intended to attain appropriate water quality for recreational uses. This guidance value was not developed to ensure safe and appropriate quality for drinking water.[49] Nevertheless, EPA relied upon a State DEC guidance value of 20 ug/L phosphorus as an interim measure.[50] Phosphorus concentrations in a reservoir above this value were deemed to exceed the concentration needed for recreational uses of the reservoir, necessitating the promulgation of TMDLs and the reduction of phosphorus loadings. Conversely, EPA deemed TMDLs for reservoirs with phosphorus concentrations below 20 ug/L as merely informational because recreational uses were not considered to be adversely affected in these water bodies.[51]

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[48] Letter from EPA Region II Administrator Jeanne M. Fox to John P. Cahill, Commissioner of State DEC, dated April 2, 1997.

[49] See NRDC v. Fox, 30 F.Supp.2d 369, 381 (S.D.N.Y. 1998).

[50] State DEC's 20 ug/L guidance value for phosphorus is listed in DEC's "Technical Operational Guidance Series No. 1.1.1, Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations" (June 1998) Table 1. The guidance value is an informational interpretation of State DEC's narrative water quality standard for phosphorus. This document states that the 20 ug/L phosphorus guidance value was "[b]ased on aesthetic effects for primary and secondary contact recreation" as opposed to drinking water protection. Indeed, the DEC was careful to note on the cover of this document that:

> This guidance document is not a fixed rule under the State Administrative Procedure Act section 102(2)(a)(i). Furthermore, nothing set forth herein prevents staff from varying this guidance as the specific facts and circumstances may dictate, provided staff's actions comply with applicable statutory and regulatory requirements. This document does not create any enforceable rights for the benefit of any party.

Id. Therefore, further refinement of the initial 20 ug/L phosphorus guidance value for Phase II TMDL calculations to specifically account for drinking water quality is fully appropriate.

[51] Letter from EPA Region II Administrator Jeanne M. Fox to John P. Cahill, Commissioner of State DEC, dated April 2, 1997.

III. A Phosphorus Value of 15 ug/L is Needed to Ensure Adequate Drinking Water Quality

We recommend that EPA adopt a phosphorus criterion of no higher than 15 ug/L in the Watershed's source water reservoirs when specifying the Phase II TMDLs. The need for phosphorus reductions is well demonstrated by the detailed studies provided by DEP scientific research staff, as well as by the independent assessment conducted by the prestigious National Research Council. The need for a more stringent TMDL is further evidenced by the serious phosphorus-induced water quality impairment of the New Croton reservoir, a reservoir with phosphorus values already below the current 20 ug/L Phase I guidance value. A more protective TMDL is consistent with Watershed contingency planning for droughts, floods, and supply-system disruptions, and could help provide useful system-wide flexibility in the future. Moreover, a 15 ug/L guidance value for the calculation of the TMDLs for all source water reservoirs is consistent with the widely accepted "multi-barrier" approach to drinking water protection.[52]

A. DEP's Phosphorus Guidance Value Study

DEP has recommended that phosphorus concentrations in its reservoirs be reduced to at most 15 ug/L based on an empirical analysis of the effects of phosphorus loadings on water quality. This analysis by DEP involved the identification of a threshold concentration of 7 ug/L chlorophyll *a* concentrations in its source water reservoirs. Chlorophyll *a* is a measure of the condition of a water body that is closely dependent on growing season phosphorus levels. DEP identified the 7 ug/L measure of chlorophyll *a* based upon reservoir data indicating that water

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[52] EPA has already found that the seven source water reservoirs in the Watershed have suffered actual or threatened deviations from water quality standards. The phosphorus concentrations of New Croton and Croton Falls in recent summer growing seasons have exceeded 15 ug/L, and EPA has listed these, respectively, as "impaired" and "stressed." Although phosphorus concentrations in the remaining five source water reservoirs have been somewhat lower, EPA has already listed these reservoirs as "threatened" in recognition of the significant phosphorus loading they already receive and the need to protect these water bodies from increasing phosphorus pollution.

Given the importance of these source water reservoirs and their actual and threatened deviations from water quality standards, TMDLs should be established for them so that phosphorus concentrations do not exceed 15 ug/L. State DEC Division of Water, "New York state 1998 § 303(d) List" April 1, 1998) attachment A, a 17-18. TMDLs are intended to apply to water bodies whose water quality is threatened as well as water bodies experiencing a current deviation from standards. See 40 C.F.R. § 130.7(c)(1)(ii) ("TMDLs shall be established for all pollutants preventing or expected to prevent attainment of water quality standards. . ;" EPA, "Guidance for Water Quality-based Decisions: The TMDL Process," (April 1991) at 12 (TMDLs should be established for "threatened good quality waters").

quality problems stemming from eutrophication increase significantly when chlorophyll *a* levels rise above this concentration. Data analysis revealed that phosphorus concentrations close to 15 ug/L were associated with problematic levels of chlorophyl *a*.[53] In addition, DEP's data analysis disclosed more frequent failures to meet water quality criteria for color, dissolved oxygen, iron and manganese in reservoirs when phosphorus concentrations were above 15 ug/L.[54]

B. The National Research Council Recommendation

Implementation of TMDLs to attain reservoir phosphorus concentrations of 15 ug/L has also been recommended by the National Research Council. The NRC Report "enthusiastically supports" the promulgation of TMDLs that achieve phosphorus concentrations of 15 ug/L in City reservoirs to "maintain eutrophication at or below an acceptable level."[55] After a detailed assessment, the National Research Council concluded that: "The new 15-ug/L phosphorus guidance value is appropriate. The Phase I [TMDL] goal of 20 ug/L was not adequately conservative for a drinking water supply, as it is based on ecological and aesthetic considerations."[56]

C. Water Quality Problems in the New Croton Reservoir

The need to attain and maintain phosphorus concentrations of 15 ug/L or lower in the Watershed's source water reservoirs is demonstrated by the serious water quality problems experienced at the New Croton reservoir. As discussed above, because of poor, eutrophic, water quality induced by excessive phosphorus in the New Croton, DEP frequently must suspend or limit the flow from this source water reservoir. This situation, while handled by DEP staff to date, has consistently created an operational nightmare for DEP officials charged with balancing the need to maintain high water quality against the need to meet high water demand during the warm weather growing season.[57]

It is important to emphasize that this history of impairment has occurred during a period when the growing season phosphorus concentrations in the New Croton were consistently less

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[53] DEP Report at 43-44.

[54] DEP Report at 44-45. DEP noted in its conclusion that even a 15 ug/L phosphorus concentration in the reservoirs will not eliminate many water quality problems, including algal blooms and low dissolved oxygen levels.

[55] NRC Watershed Report at 255.

[56] NRC Watershed Report at 258.

[57] New Croton flow suspensions and water blending (as evidenced by reductions in flows) are presented for 1990 to 1997 in Figures 5 and 6 of the Appendix.

than 20 ug/L (the phosphorus concentration established in Phase I TMDLs) but greater than the recommended 15 ug/L concentration. These phosphorus concentrations were as follows: 1992 - 17.4 ug/L, 1993 - 17.3 ug/L, 1994 - 18.7 ug/L, 1995 - 16.6 ug/L, 1996 - 16.4 ug/L.[58] The evidence of New Croton's eutrophic condition at these phosphorus concentrations strongly supports reducing the present 20 ug/L phosphorus concentration to 15 ug/L.

Impairment of water quality has led to impairments in DEP's ability to supply water from the New Croton, as illustrated in a series of graphs based on data provided by DEP. As can be seen from Figures 1 through 4 of the Appendix, the flow of water from the New Croton reservoir drops off precipitously as certain water quality criteria values approach conditions of poor water quality. Figure 1 shows how DEP moved to suspend the use of New Croton waters in late August and September of 1994 as customer complaints concerning water quality increased in the July and August growing season of that year.

Figure 2 shows the strong relationship between water color and water supply in New Croton. As color increased through August 1994, DEP was forced to very rapidly reduce flow, to the point of a complete shutdown by late August when the maximum contaminant level for color (15 color units) was exceeded.[59] Similarly, Figure 3 shows how rapidly increasing levels of manganese in post-chlorinated water preceded the suspension of New Croton during this period. While the manganese level did not exceed the maximum contaminant level, DEP was forced to shut off the New Croton as the levels began to rise quickly. Finally, Figure 4 shows the relationship between flow and dissolved oxygen in the New Croton in 1994. This figure shows violations of maximum contaminant levels for dissolved oxygen in August and September of that year.

D. Phosphorus Impacts and the "Multiple Barrier" Approach

It is generally accepted that multiple levels of protection are useful to fully safeguard public drinking water supplies. This is particularly important for reservoir systems that serve large populations because the introduction of contaminants into the system can adversely affect many people. Indeed, once contaminated water enters the distribution system, essentially all control is lost. Therefore, it is important that adequate controls are put in place to better prevent contaminants and pathogens from entering the drinking water distribution system at all. This public health policy should apply to EPA's specification of a phosphorus guidance value during its Phase II TMDL process for all Watershed source water reservoirs, whether or not the water from a particular reservoir will ultimately be subjected to filtration.

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[58] DEP New Croton Report at 17.

[59] It is important to note that water color is not merely an aesthetic characteristic. Excessive color or opacity in water is often associated with poor taste and odor, and can be an indicator for other water quality problems, such as high metal content.

As recognized by EPA and the American Water Works Association, strong policy and scientific reasons support the "multiple barrier" approach to managing drinking water quality.[60] According to the National Research Council, examples of barriers that may be employed by water quality managers include: "selecting the highest-quality source water, practicing watershed management, using the best available treatment technologies, maintaining a clean distribution system, practicing thorough monitoring and accurate data analysis, having well-trained operators, and maintaining operating equipment."[61]

The National Research Council identified a number of attributes of effective watershed management: "(1) establishment of goals and objectives, (2) an inventory of the watershed and assessment of possible contaminant sources, (3) development and (4) implementation of protection strategies, and (5) monitoring and evaluation of program effectiveness."[62] EPA's TMDL program -- including the phosphorus concentration criteria adopted by EPA as part of that program, critically influence each of these five steps. Without the establishment of a meaningful phosphorus criterion and TMDL from the beginning, the effectiveness of watershed management as a protective barrier is significantly reduced.

As stated by Kim Fox, an EPA environmental engineer who investigated the 1993 outbreak of waterborne disease in the *chemically filtered* Milwaukee water supply where 400,000 people were sickened: "since none of these barriers (watershed protection, filtration, and disinfection) is perfect, a multiple barrier approach which incorporates all three provides the greatest protection to public health from microbiological contamination and other public health risks."[63] Simply put, the anticipated use of filtration for the Croton portion of the Watershed in 2007 does not justify a softening of efforts to protect water at its source from phosphorus pollution. Charles Perrow, author of the classic book about high risk systems, Normal Accidents, has an apt name for the theory of multiple barriers of protection: "defense in depth." Perrow notes that "nothing is perfect; every part of every system, industrial or not, is liable to failure," thus providing the fundamental rationale for the multiple barrier approach.[64]

The need for source water protection even where filtration is employed is illustrated by the

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[60] See, e.g., American Water Works Association, "Source Water Protection Statement of Principles," AWWA Mainstream (1997); EPA, "State Source Water Assessment and Protection Programs Guidance -- Draft Guidance" (EPA 816-R-97-007) (Office of Water).

[61] NRC Watershed Report at 97.

[62] NRC Watershed Report at 98.

[63] Declaration of Kim R. Fox, United States v. City of New York, July 9, 1997, (E.D.N.Y. Civ. Act. No. 97-2154).

[64] C. Perrow, Normal Accidents, Basic Books, 1984 at 40, 43.

outbreak in March and April of 1993 of water-borne disease in Milwaukee, Wisconsin, resulting from the entry of *Cryptosporidium* oocysts into the public water supply. At the time, there were only limited controls in place for the Milwaukee watershed. When the outbreak occurred, the filtration plant was apparently not operating at peak efficiency. These operational difficulties coincided with a period of unusual weather conditions, which led to higher levels of turbidity in the source water and greater numbers of water-borne pathogens. Because of the high turbidity, both the filtration and the disinfection barriers failed, leaving 400,000 sick and about 100 dead.[65] While one cannot conclude that adequate source water protection would have prevented the outbreak, the absence of such protections certainly contributed to the problem.

E. Maintenance of the Water Supply During Droughts and Other Adverse Conditions

More protective TMDLs make good sense in light of the serious water quality and water supply problems that may result during drought, flood or unforeseen water supply system disruptions. High water quality throughout the Watershed also provides for system flexibility in the event of the need to rehabilitate major water supply infrastructure.

For example, over the last few summers, rainfall has been well below average in the Catskill and Delaware portions of the Watershed, often leaving water levels in these reservoirs much lower than normal. Drought conditions tend to decrease water quality. The Croton portion of the Watershed generally is much less prone to droughts and therefore could act as a reserve water supply during shortfalls in the Catskill/Delaware system. During past droughts, Croton water has grown from 10% of the supply to upwards of 25%. Poor water quality in the New Croton, due to excessive phosphorus loads, would interfere with the Croton system's ability to provide high quality water to meet such shortfalls, especially during the summer and fall, when DEP often has to reduce or suspend flow from the New Croton. A similar situation could arise if a major storm or flood event caused large amounts of turbid water to overwhelm portions of the Catskill/Delaware system -- creating a need to place increased reliance on the Croton system waters.

Finally, DEP may seek in the future to expand its ability to transfer Croton system waters into the waters flowing from the Catskill/Delaware system. Applying a phosphorus TMDL that maximizes the quality of the source water of the Croton reservoirs will help preserve such an option.

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[65] J. Rose, "Environmental Ecology of *Cryptosporidium* and Public Health Implications," Annual Review of Public Health (1997) at 137; M. Parlange, "Parasites in the Pipes," BioScience at 360 (May 1999).

IV. A Phosphorus Concentration of 15 ug/L is Consistent With the Clean Water Act

Lowering the phosphorus concentration criterion to a maximum of 15 ug/L would be fully consistent with the Clean Water Act's TMDL provisions. Section 303(d) of the Clean Water Act requires that TMDLs be set "at a level necessary to implement the applicable water quality standards."[66] The earlier Phase I TMDLs, however, were established based on a water quality guidance value of 20 ug/L -- a value that had been developed to protect recreational and aesthetic attributes, rather than to protect drinking water.[67] The currently proposed 15 ug/L phosphorus concentration was developed by DEP specifically to assure that water quality standards applicable to a source of drinking water will be attained.[68] Therefore, to better conform with the Clean Water Act's mandate, EPA should employ a phosphorus concentration of 15 ug/L when adopting the pending Phase II TMDLs for the Watershed's seven source water reservoirs.

As discussed in detail above, evidence of deficient water quality in New Croton is substantial. In fact, State DEC regards the New Croton as one of the two most phosphorus-impaired reservoirs in the New York City Watershed.[69] This adverse condition persists in the New Croton even though it has phosphorus concentrations below the 20 ug/L guidance value employed by EPA in the earlier Phase I TMDL process. Thus, the prior TMDL failed to perform its intended function, as the earlier effort did not sufficiently limit the phosphorus pollution that causes eutrophication of Watershed reservoirs.

There is substantial evidence that revising Watershed TMDLs to achieve phosphorus concentrations of 15 ug/L should result in the attainment of water quality standards. As DEP's Report concluded after a thorough empirical analysis, reducing phosphorus concentrations to less than or equal to 15 ug/L should greatly limit water quality problems due to phosphorus-induced eutrophication.[70] Significantly, the National Research Council concurred by "enthusiastically" supporting phosphorus concentrations of 15 ug/L in Watershed reservoirs.[71] In fact, the

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[66] 33 U.S.C. § 1313(d)(1)(C).

[67] DEC's "Technical Operational Guidance Series No. 1.1.1, Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations" (June 1998) Table 1. See also DEP Report at 43.

[68] DEP Report at 27-49.

[69] State DEC Division of Water, "New York State 1998 § 303(d) List" (April 1, 1998), attachment A, at 17-18.

[70] DEP Report at 47 to 48.

[71] NRC Watershed Report at 255.

Council's report found that the 20 ug/L phosphorus concentration underlying the present Phase I TMDLs "was not adequately conservative for a drinking water supply."[72] Moreover, given the statutory command to incorporate a "margin of safety" into the TMDL calculations so as to better assure compliance with water quality standards, see 33 U.S.C. § 1313(d)(1)(C), these findings strongly support lowering the allowable phosphorus concentration in the Watershed's source water reservoirs.

Based upon the substantial expert evidence and evaluation supporting a phosphorus guidance value of 15 ug/L for use by EPA when specifying TMDLs, a decision in favor of this protective measure by EPA would receive great deference from the courts.[73]

CONCLUSION

For all these reasons, it is respectfully requested that EPA employ a phosphorus criterion that is no higher than 15 ug/L when specifying TMDLs for the seven "source water" reservoirs of the New York City Watershed.

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[72] NRC Report at 258.

[73] See Natural Resources Defense Council, et al. v. Fox, et al., 94 Civ. 8424, May 2, 2000 (S.D.N.Y., Leisure, J.) slip op. at 41-45, 53; see also United States v. Akso Coatings of America, Inc., 949 F.2d 1409, 1424 (6th Cir. 1991) (agency decision based on "informed scientific opinion. . . [is] entitled to great deference"); accord Baltimore Gas & Electric Co. v. Natural Resources Defense Council, Inc., 462 U.S. 87, 103 (1983).