United States Environmental Protection Agency Region 2

ASSESSING NEW YORK CITY'S WATERSHED PROTECTION PROGRAM

THE 1997 FILTRATION AVOIDANCE DETERMINATION MID-COURSE REVIEW FOR THE CATSKILL/DELAWARE WATER SUPPLY WATERSHED

May 2000

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EPA's Filtration Avoidance Determination Mid-Course Review for the Catskill and Delaware Water Supply

Executive Summary

At the mid-point in EPA's Filtration Avoidance Determination for New York City's Catskill and Delaware water supply, EPA concludes that, while the City has made great strides in many areas of its Watershed Protection Program, it must implement a number of corrective actions for specific FAD Tasks and program enhancements to ensure the long-term viability of filtration avoidance. This Executive Summary highlights some of EPA's most significant findings and recommendations concerning the City's Watershed Protection Program. EPA concludes that, in order for the City to maintain filtration avoidance, these recommendations (all of which are described in more detail in the "Key Findings and Recommendations" section of this report), must be substantially addressed prior to EPA's next filtration determination, set for April 2002.

EPA commends the City for many significant program accomplishments. The City:

- continues to provide safe, clean drinking water that meets all federal drinking water standards, meets the objective criteria for filtration avoidance, and samples regularly for *Giardia* and *Cryptosporidium*, for which there are currently no federal Maximum Contaminant Levels;

- has developed and implemented a multi-tiered disease surveillance program, which serves as a model elsewhere in the country;

- has implemented an extensive watershed and distribution system sampling program to protect New Yorkers from waterborne disease;

- is effectively working with upstate farm communities --- almost 90% of the farms are participating in the voluntary Watershed Agricultural Program, and over 70% are executing approved "whole farm plans" designed to reduce pollutants leaving the farm;

- has acquired or has under contract approximately 20,000 acres of watershed land, including over 5,000 acres in the important West Branch/Boyd's Corner watershed;

- has worked with upstate communities to repair or replace over 1000 septic systems;

- has upgraded the treatment technology to microfiltration at the six City-owned sewage treatment plants --- this accounts for 40% of the sewage discharged in the watershed;

- has worked with the State to increase compliance with current State permits at sewage treatment plants in the watershed --- there has been a drop in significant non-compliance from 30% in 1995 to 8% in 1999, and all significant non-compliance is being addressed through formal enforcement actions.

EPA strongly recommends that the City focus its efforts on a number of corrective actions for specific FAD Tasks and program enhancements. The City is falling behind in some key areas, which must be substantially addressed prior to EPA's next filtration determination. The two most critical areas where the City must significantly better its efforts are: acquiring land or conservation easements around the Kensico Reservoir, where nearly all of the water from the Catskill/Delaware system flows before it enters the distribution system, and where the City has only purchased 17 acres out of 1000 acres available for solicitation; and upgrading the treatment technology at the 34 non-City-owned sewage treatment plants that account for 60% of the sewage discharged in the Catskill/Delaware watershed (the City is also required by the Watershed MOA to upgrade the sewage treatment plants in the Croton system, bringing the total to more than 100). Additional corrections and enhancements which the City must substantially address prior to 2002 (and which are described in more detail in the "Key Findings and Recommendations" section) include:

- expand to the Rondout and West Branch Reservoirs its successful Waterfowl Management Program, designed to reduce the amount of waterfowl fecal matter (a source of coliform) that enters reservoirs;

- develop a strategy to further reduce non-point source pollution, such as storm water runoff and failing septic tanks, in the Catskill/Delaware watersheds east-of-Hudson;

- expedite completion of Stream Management Plans and demonstration projects to reduce water turbidity;

- aggressively review all permit applications that come in to the Army Corps of Engineers under its Nationwide Permit program for wetlands fill resulting from development and construction, and set a goal of increasing wetlands acreage in the watershed;

- strengthen public outreach efforts to communities affected by watershed issues;

- develop a long-term mechanism to better detect and correct failing septic systems;

- get more involved at an earlier stage in the State Environmental Quality Review Act (SEQRA) process, which requires local agencies to study environmental impacts of development actions, and map impervious surfaces in the watershed;

- conduct an analysis of the entire watershed monitoring program to ensure that it can detect trends and measure pollutant reductions, within basins and watershed-wide; and

- reinstate its Annual Water Quality Report (last published in 1993), in order to integrate and analyze the large amount of data that are collected throughout the watershed, and ensure that

as much water quality information as possible is released to the public.

EPA also recommends that the City carefully review and follow-up on the full set of findings and recommendations contained in the body of this report that are intended to assist the City in enhancing its Watershed Protection Program.

Key Findings and Recommendations

While the City has made great strides in many areas of its Watershed Protection Program, it must implement a number of corrective actions for specific FAD Tasks and program enhancements to ensure the long-term viability of filtration avoidance. This section outlines EPA's most significant findings and recommendations concerning the City's Watershed Protection Program. EPA concludes that, in order for the City to maintain filtration avoidance, these recommendations must be substantially addressed prior to EPA's next filtration determination, set for April 2002. Furthermore, EPA has included a number of additional findings and recommendations in the detailed sections of the report that are intended to assist the City in enhancing its Watershed Protection Program.

Introduction

EPA's Filtration Avoidance Determination (FAD) applies to the City's Catskill/Delaware drinking water supply system. This system consists of the four Delaware reservoir watersheds (Cannonsville, Pepacton, Neversink and Rondout) and the two Catskill reservoir watersheds (Ashokan and Schoharie) west of the Hudson River. Since the Delaware aqueduct connects directly with the West Branch Reservoir and since water from the Catskill/Delaware system is normally discharged into the Kensico Reservoir, the system also includes the West Branch-Boyd's Corner Reservoir and Kensico Reservoir watersheds, both east of the Hudson River.[1]

EPA's FAD requires that "prior to the April 15, 2002 determination, the EPA, in consultation with the

[1] Under EPA's FAD, Cross River and Croton Falls Reservoir watersheds are not considered part of the Catskill/Delaware system. The Cross River and Croton Falls Reservoirs are part of the City=s Croton water supply system, which, pursuant to the Consent Decree entered in United States v. City of New York, must meet all filtration treatment requirement no later than March 2007. Some commenters noted that these two watersheds should be considered part of the Catskill/Delaware water supply system for the purposes of filtration avoidance. They state that water from the Cross River and Croton Falls reservoirs is periodically transferred to the Catskill/Delaware water supply system, and believe that the City will increase its use of these water transfer points in the future. The Cross River and Croton Falls pump stations are used on a limited, drought or emergency basis, and only with EPA and NYSDOH prior approval, in accordance with the FAD and the Croton Consent Decree. (These pump stations were last utilized over three years ago.) Once the Croton filtration plant is operational, the need to use Cross River and Croton Falls pump stations should be further reduced. However, under the existing Consent Decree, the Croton Filtration Plant is not expected to be operational until 2007. It is EPA's position that the City must vigorously implement and enforce the Watershed Rules and Regulations, other provisions of the Watershed MOA, and institute all measures necessary, as part of a multi-barrier approach to watershed protection, to ensure maximum protection of these two Croton reservoirs. Furthermore, in exercising its emergency approval authority, under the FAD and Consent Decree, both before and after the Croton system is filtered, EPA will only approve water transference if the City can show that these two reservoirs are being adequately protected as emergency water sources to an unfiltered water supply system. EPA is prepared to deny the City emergency access to the Croton Falls and Cross River Reservoirs if it believes the City is not diligently acting to protect them. EPA intends to further examine this issue prior to the next FAD, set for April 2002.

City and NYSDOH, will formally review and evaluate the City's compliance with the terms and conditions of the 1997 FAD by April 15, 2000." In addition, the Watershed Memorandum of Agreement (MOA) requires that EPA review "the City's compliance with the terms and conditions of the 1997 FAD ... on or before May 31, 2000."

This review evaluates the City's compliance with the terms and conditions of the 1997 FAD, thereby meeting EPA's obligation under the FAD and the MOA. In addition, it makes recommendations for enhanced watershed protection intended to increase the prospects that the City will qualify for long-term filtration avoidance. A comprehensive, mid-course review is in the best interest of all watershed stakeholders. It allows EPA to identify the elements of the City's current watershed protection program that need immediate attention, and to identify the overarching issues that need to be addressed by the City in the longer-term. To all stakeholders, this review offers a clear picture of what EPA considers necessary to implement an effective water supply protection program in the New York City watershed. In short, this review will help set the stage for a future FAD.

EPA has taken a critical look at the watershed protection programs, their objectives, the strategies in place to meet those objectives, and the City's capabilities to determine whether those objectives are being met. A fundamental shift is taking place in the filtration avoidance program. Since the first conditional FAD was issued in January 1993, the primary focus has been on developing and implementing watershed protection and remediation programs. As these programs move from the planning to the implementation phase, it becomes imperative that resources be targeted to program evaluation and to program enhancement.

The mid-course review has also provided an additional opportunity to hear from watershed stakeholders whose interest in, and support for, the City's watershed protection efforts will influence the success or failure of the program. EPA believes that long-term filtration avoidance is dependent on the involved communities being participants in shaping, implementing and supporting the programs and actions to protect the watershed. EPA actively solicited stakeholder input through a number of venues, including public information sessions and small-group meetings, and considered this process a very important element of the review. EPA appreciates the many invaluable comments that it received; this input is reflected throughout EPA's FAD mid-course review. Some comments, however, were directed at significant watershed protection issues that are beyond the scope of the FAD. To ensure that all comments are appropriately addressed, EPA is currently developing a document that responds to concerns that were raised during the FAD mid-course review.

Objective Criteria Compliance

Since the inception of the 1997 FAD, NYCDEP has successfully demonstrated that the Objective Criteria for filtration avoidance have been met. The City's strategy to comply with the Objective Criteria tasks of the FAD meets the requirements of the Surface Water Treatment Rule (SWTR) for

unfiltered water supplies. Water quality data analysis shows that fecal coliform levels, turbidity and disinfectant byproduct levels are all within acceptable limits. NYCDEP has never incurred a monthly maximum contaminant level (MCL) violation, and there has not been an acute MCL violation since 1994. The 0.10 mg/l MCL for total trihalomethanes has never been exceeded. And finally, distribution system monitoring has shown that adequate (detectable) disinfectant concentrations are being maintained throughout the distribution system in compliance with the requirements for unfiltered systems. In accordance with the Total Coliform Rule (TCR) (enforcement of which is delegated to the New York State Department of Health), the City must take a minimum of 480 samples per month to determine compliance with the TCR and SWTR. ("Compliance" sampling sites are located on distribution mains 20 inches in diameter or less which serve water directly to consumers.) In fact, NYCDEP takes approximately 960 samples/month for compliance purposes. In addition, it takes approximately 350 surveillance samples/month throughout the distribution system.

In support of the Objective Criteria requirements of the SWTR, the FAD requires that the City implement two programs to prevent contamination of the drinking water supply through the distribution system: the Low Chlorine Residual Remediation Program and the Cross Connection Control Program. The Low Chlorine Residual Remediation Program has succeeded in meeting its goals. Chlorine residuals have been detectable at all the compliance and surveillance sampling locations. The Cross Connection Control Program adequately addresses EPA's concern about potential cross connection contamination in the distribution system. A mechanism to address complaints and to inspect all facilities that may have cross connections is currently in place.

In addition to the current filtration avoidance criteria in the SWTR and the new criteria in the Interim Enhanced SWTR (effective 2002), EPA has an advisory committee discussing future disinfectant byproduct and surface water treatment requirements. The advisory committee, chartered under the Federal Advisory Committee Act, includes a member representing large unfiltered systems. The committee will be discussing, and may recommend, additional filtration avoidance criteria. Any new criteria may have to be met as early as May 2005 (based on these rules being finalized in May 2002). **If new criteria are promulgated, EPA and New York City will need to address those criteria as part of any future filtration avoidance determination.** EPA notes that NYCDEP maintains a qualified professional science and engineering staff to anticipate and understand potential new rule changes that may impact monitoring and water quality control components of the FAD. In addition, NYCDEP personnel actively participate on workgroups formed by EPA to address drinking water rule revisions.

Disease Surveillance Program

The overall objectives of the Disease Surveillance Program are to track the incidence of, and gather epidemiological data on, two waterborne diseases, giardiasis and cryptosporidiosis, and to develop/maintain a system to detect disease outbreaks of possible waterborne transmission. The City's

strategy to address the specific objectives of the 1997 FAD was to implement four interlocking programs: (1) *active disease surveillance* for giardiasis and cryptosporidiosis, (2) sentinel surveillance for waterborne disease *outbreak detection*, (3) *epidemiological studies*, and (4) *educational outreach*.

Although active disease surveillance is subject to under-reporting, it is an important element of the City's multi-tiered Disease Surveillance Program. The City's Outbreak Detection Program is to be commended. The City collects data from three surveillance sources to detect trends across surveillance programs. New York City is breaking ground in this still-developing field, and some of its program elements were featured in a 1997 Centers for Disease Control and Prevention manual, *Cryptosporidium and Water: A Public Health Handbook*. In addition, the City's outreach and education efforts to date have been impressive. Over the last several years, NYCDEP and the New York City Department of Health have made presentations to physicians and other health care providers on, among other issues, the need to request specific laboratory testing for cryptosporidiosis when the disease is suspected. EPA has made a number of recommendations in Chapter II which, if implemented, should further enhance the Disease Surveillance Program.

Land Acquisition

Land acquisition is one of the most effective and, therefore, vital mechanisms to permanently protect the City's Catskill/Delaware watershed. The overarching goal of the Land Acquisition Program is to ensure that undeveloped, environmentally-sensitive watershed lands remain protected, and that the watershed continues to be a source of high-quality drinking water to the City and upstate counties. Its success is critical to EPA's continuance of filtration avoidance for the Catskill/Delaware system.

EPA commends the City for meeting all of its solicitation goals as outlined in the FAD and MOA at the three-year point in the Land Acquisition Program (January 21, 2000). To date, the City has shown significant progress in acquiring land in a number of basins, particularly West Branch, where it has acquired or executed purchase contracts on 5,389 acres, or 38% of the land it has solicited. Unfortunately, progress is poor in Kensico, probably the most critical watershed in the Catskill/Delaware system, where, out of 1000 acres available for solicitation, only 17 acres (2% of the land that has been solicited) have been acquired or are under contract. NYCDEP has stated that it is actively negotiating with a number of landowners and that it expects to make additional purchases in the Kensico basin shortly. **EPA strongly recommends that the City re-double its efforts, using all means available, to acquire land or conservation easements to protect the remaining open space in the Kensico watershed. To that end, EPA recommends that the City develop an intensive solicitation/acquisition strategy, specific to the Kensico watershed, and report on the progress of implementing that strategy to EPA within one year's time. If significant progress in acquiring land or easements is not made in the near term, the City must work with the local governments to ensure that they use their land use authorities**

to protect this vitally important Catskill/Delaware watershed. In light of the lack of program progress thus far in Kensico, EPA has particular concerns regarding the use of Nationwide Permits for wetlands fill projects in the Kensico watershed. EPA has recommended to the New York District of the Army Corps of Engineers that use of Nationwide Permit 39 be prohibited from use in the watersheds east-of-Hudson. This would ensure that any development project that impacts wetlands is subject to a full review under the federal wetlands regulatory program.

In accordance with the FAD, the City has completed soliciting land in Priority Areas 1 and 2. **EPA recommends that the City continue its efforts to acquire critical watershed lands by periodically re-soliciting landowners in Priority Areas 1 and 2.** In the remaining years of the Land Acquisition Program, the City is scheduled to solicit land only in Priority Areas 3 and 4. With this shift, the City will have much more flexibility in deciding which land to solicit. **EPA recommends that the City develop a plan to prioritize the solicitation of land in Priority Areas 3 and 4. EPA recommends that the plan make full use of the City's water quality monitoring data and terrestrial models, and that it include a direct link to the objectives of the Stream Management and Wetlands Protection Programs. EPA recommends that the City maximize use of its Geographic Information System (GIS) to facilitate these efforts.**

Watershed Agricultural Program

The overall objective of the Watershed Agricultural Program (WAP) is to prevent pollution, and to improve water quality, by reducing pollutants leaving the farm through the implementation of "best management practices" (BMPs). The WAP is designed to meet this objective through the voluntary development and implementation of Whole Farm Plans on at least 85% of the farms in the New York City watershed. A secondary objective of the WAP is to conduct scientific research in support of agricultural management practices utilized in the watershed. Through December 1999, each of the key milestones required by the FAD has been met. Almost 90% of the farms in the watershed are participating in the WAP. Furthermore, a satisfactory level of program implementation has been achieved to date, with 73% of watershed farms currently executing approved Whole Farm Plans.

The program addresses a broad geographic area which is a significant source of pathogens, phosphorus and sediment. The program has implemented BMPs that are widely accepted as having the potential for reducing agricultural pollutants and resulting runoff. Examples of BMP categories include (1) improved herd health (which decreases the potential number of pathogens available for transport to a waterbody), (2) redirection of clean runoff away from areas with high concentrations of contaminants (which decreases the pollutant load reaching the waterbody), and (3) identification of hydrologically sensitive areas to avoid manure spreading (which decreases the runoff of pollutants). Over 1,000 BMPs have been instituted to date. In addition, the WAP has continued to advance program goals through several initiatives not required by the FAD, such as the Forestry, Whole Farm Easement and Conservation Reserve Enhancement Programs. These programs provide additional opportunities for

pollution prevention, and provide incentives for farmer participation. They also demonstrate a strong commitment by NYCDEP, and by the Watershed Agricultural Council, to conducting an integrated, multi-tiered Watershed Agricultural Program. New York City is commended for supporting these initiatives, which go beyond the requirements of the FAD.

To fully evaluate the effectiveness of the WAP in maintaining or enhancing water quality, the reduction of pollutant loads by the implementation of Whole Farm Plans must be determined. Water quality monitoring and water quality models are tools to aid in this determination. NYCDEP and the Watershed Agricultural Council have secured funds to conduct monitoring in the Town Brook sub-basin. In addition, Delaware County, in support of its Phosphorus Reduction Strategy, has obtained funds to conduct a study of the reduction of agricultural phosphorus through intensive forage management. Also, NYCDEP conducts extensive routine monitoring in the Cannonsville Reservoir basin. A monitoring program is in place to measure water quality at one farm, and additional monitoring to evaluate management practices is scheduled to begin this year. As the WAP matures, and the program moves from planning to implementation, these and other efforts will be necessary to determine the overall impact of the WAP on water quality. EPA has made a number of recommendations in Chapter IV which, if implemented, should further enhance the Watershed Agricultural Program.

Kensico Modeling and Remediation Programs

The Kensico Reservoir, in central Westchester County, is the terminal reservoir for the City's Catskill/Delaware water supply system. Under normal operating conditions, almost all water from the Catskill/Delaware watersheds (which supplies 90% of the City's water) flows through the Kensico Reservoir, prior to being chlorinated and sent to the City via the Catskill and Delaware aqueducts. The overall objective of the Kensico Modeling and Remediation Programs is to improve water quality in the Kensico Reservoir by identifying sources of contaminants and by instituting appropriate source prevention and remediation measures. The City has instituted numerous program elements to meet this objective.

The Kensico Stormwater Control Program (KSWCP) is one of four programs recommended in NYCDEP's 1995 Kensico Water Pollution Control Study. The objective of the KSWCP is to identify and remediate the sources of fecal coliform bacteria and turbidity being conveyed to the Kensico Reservoir by stormwater runoff, through the implementation of *source reduction* and *pollutant removal* BMPs. Although the City was late in implementing Phase I of the program, it expects to complete the entire program by the end of 2000, well before the completion date specified in FAD (mid-2002). A contract has been awarded, and a contractor is in the field installing BMPs. EPA commends NYCDEP for expediting construction and pursuing an aggressive target completion date of 4th quarter 2000 for the entire Kensico Stormwater Control Program. The long-term success of the KSWCP will be gauged by water quality improvement in stormwater flow entering the Kensico Reservoir. Thus, evaluating the effectiveness of the Kensico stormwater BMPs is critical. NYCDEP

recently completed a stormwater monitoring plan for this purpose.

Under the 1997 FAD, NYCDEP was required to complete the Kensico Maintenance Dredging Program by the end of October, 1998. The City successfully completed the program on May 12, 1999. Although 6 months late, the FAD objective was satisfied. By removing the sediment adjacent to Shaft 18 and the Catskill Upper Effluent Chamber, the City eliminated a potential source of turbidity and fecal coliform bacteria which, if resuspended during storm events, could have contaminated the City's water supply.

Gull and waterfowl roosting near effluent chambers and other areas around the Kensico Reservoir were a dominant source of fecal coliform bacteria loading in the reservoir through the early 1990s. The objective of the City's Waterfowl Management Program is to eliminate roosting birds from the Kensico Reservoir during the migratory season, thereby eliminating a significant source of contamination to the reservoir, and substantially improving water quality. Since implementation of this program, fecal coliform bacteria levels have decreased dramatically in the fall-winter months, and seasonal bypassing of Kensico (a common event in the early 1990s) has not been necessary since 1993. The City has noted that Rondout and West Branch reservoirs show seasonal waterfowl population increases similar to those seen at Kensico, and that these increases seem to coincide with increases in coliform levels entering Kensico. Therefore, control of fecal coliform sources in these reservoirs is also important. **EPA recommends that NYCDEP expand its Waterfowl Management Program to the Rondout and West Branch Reservoirs in order to continue to reduce the risk of fecal coliform bacteria loading in the Kensico Reservoir (and in the Catskill/Delaware system in general).**

The City also includes the following programs to support its protection and remediation efforts in Kensico: (1) a temporary curtain wall between the Catskill Upper Effluent Chamber and Malcolm Brook, (2) wastewater evaluation and control, (3) ground water monitoring, (4) surface water monitoring (reservoir and streams), (5) Kensico Water Quality Model, and (6) public education and outreach. EPA has conducted a detailed evaluation, with recommendations, on all of the above programs; this evaluation can be found in Chapter V of the report. As these programs move into the implementation and monitoring phase, EPA will continue to evaluate whether additional measures (e.g., stormwater BMPs) are necessary to protect the Kensico Reservoir.

Non-Point Source Control Programs

The objective of the NYCDEP's Non-Point Source Control Programs is to reduce or eliminate pollutant runoff from reaching the City's reservoirs and reservoir tributaries. Non-point source pollution is generated from a diversity of sources: failing septic systems, nutrient and pesticide application on landscaped and agricultural areas, inadequate road sand and salt storage, erosion from construction sites, unstable stream reaches and poorly managed timber operations, and runoff from impervious surfaces. Programs addressing non-point sources of pollution are being implemented by the City, or by

others through City funding, in the Catskill/Delaware basins located west-of-Hudson. Some of these programs are highlighted in the "Key Findings and Recommendations" section; most are critiqued, in detail, in subsequent chapters.

Non-point source pollution mitigation programs are also eligible for funding under the City-funded ($68 million) east-of-Hudson Water Quality Investment Program. However, there is no assurance that this county-directed program will address non-point source pollution, let alone non-point source pollution in the Catskill/Delaware basins located east-of-Hudson. **EPA recommends that NYCDEP develop a detailed strategy to address non-point sources of pollution in the Catskill/Delaware basins located east-of-Hudson. EPA recommends that this strategy focus on key non-point sources of pollution such as stormwater runoff, failing septics and streambank erosion.**

Stream Restoration and Turbidity

NYCDEP's Stream Management Program addresses turbidity emanating from damaged stream reaches. Geomorphic restorations will improve overall water quality in affected watershed streams and receiving reservoirs. To date, NYCDEP has made significant progress in implementing the first element (education, training and public outreach) of its strategy. However, NYCDEP's implementation of the strategy's final element (development of Stream Management Plans and implementation of demonstration projects) has experienced significant delays. The success of the outreach effort has generated considerable expectation among the Catskill communities that project implementation is imminent. There is a window of opportunity that the City must seize for this program to be successful.

Although the City has completed one demonstration project along the Batavia Kill, a number of stream restoration projects are "stuck" in the pipeline (e.g., Broadstreet Hollow). Integral to providing a framework to all of these projects are Stream Management Plans, none of which has been completed. **EPA strongly recommends that NYCDEP expedite completion of Stream Management Plans in priority sub-basins, and expedite completion of demonstration projects at Broadstreet Hollow, Big Hollow, Stony Clove, Red Falls and the West Branch of the Delaware River. EPA also recommends that NYCDEP begin Stream Management Plans in other sub-basins targeted in its Stream Management Plan implementation schedule.**

Success of the program will be partly established through biomonitoring data taken along streams near restoration projects. NYCDEP submitted its first biomonitoring report in January 2000, five years after the biomonitoring effort began; it acknowledges work to be done. Turbidity monitoring, keyed to specific restoration projects, is also necessary to assess program effectiveness and water quality improvement. **EPA recommends that NYCDEP expand its biomonitoring and pre- and post-**

remediation turbidity monitoring to measure the water quality benefit derived from its Stream Management Program. In addition, EPA recommends that the City evaluate, interpret and present these data on a more frequent basis.

Wetlands

Wetlands play a major role in watershed protection. Preventing the further loss or degradation of remaining wetlands in the watershed is an important objective of the City's Wetlands Protection Program. Success of the City's Program is measured through monitoring the change in wetlands acreage and functions over time. Currently the Program contains no methodology to quantify these changes and, thus, is not geared towards measuring success. The 1997 National Wetlands Inventory, and recent studies on wetlands trends and characteristics in the Croton watershed (1999) are a step in the right direction. **EPA recommends that the City:**

- **Develop an objective measure of progress for its Wetlands Protection Program;**
- **Expand the wetlands function analysis it performed in the Croton watershed to the entire Catskill/Delaware watershed;**
- **Review all Pre-construction Notifications under the Army Corps of Engineers' Nationwide Permit Program to mitigate wetland losses, and to recommend to the Corps that proposed fill projects that may negatively impact water quality go through the Individual Permit process; and**
- **Analyze wetlands trends, document wetlands losses/gains, and direct its Wetlands Protection Strategy accordingly.**

In addition, EPA recommends that NYSDEC and the City work with communities to reclassify those wetlands of "unusual local importance" as State wetlands.

The stated goal of the City's wetlands protection strategy is to "protect wetlands in the watershed." Recognizing the importance of wetlands, the federal Clean Water Action Plan sets a goal of reversing the trend of wetlands loss nationwide with a net increase of 100,000 acres each year, beginning in 2005. **Consistent with the Clean Water Action Plan, and considering the vital role that wetlands play in the New York City watershed, EPA recommends that the City set a goal of increasing wetlands acreage in the watershed.**

Community Outreach and Education

For the City's Watershed Protection Program to be truly successful, it must be understood, accepted, and ultimately embraced by those who live in the watershed and those who drink its water, all of whom are stakeholders in protecting the City's water supply reservoir system. There will always be conflicts (economic, social, and environmental), but a strengthened knowledge of watershed issues and environmental awareness among all stakeholders will facilitate conflict resolution and improve the chances of program success. NYCDEP has initiated, or is an active participant in, a number of excellent outreach/education efforts. In addition, the City has significantly enhanced its webpage by providing weekly pathogen monitoring data, the Waterborne Disease Risk Assessment Annual Report, and periodic updates of watershed protection efforts.

Although laudable, the City's education efforts are generally geared to specific watershed programs. Comments to EPA during the mid-course FAD review suggested that NYCDEP could improve its relationships with upstate and downstate communities by providing more avenues, tailored to meet community needs, for public input on general watershed issues. An effective feedback mechanism needs to be developed so that the City hears about issues before they become full-blown, intractable problems forcing residents to take sides. **In order to assist the City in its watershed protection efforts, EPA recommends that NYCDEP strengthen communication with, and forge partnerships with, watershed communities. Specifically, EPA recommends that the City:**

- **Engage communities with watershed workshops, periodic town meetings, citizen advisory committees, newsletters and public opinion surveys;**

- **Develop a public notification protocol to address pathogens entering the water supply system and spikes in disease surveillance/outbreak detection data.** (This is an important step in preventing/containing an outbreak of waterborne gastrointestinal illness); and

- **Enhance its webpage with (1) FAD (and other) watershed protection/water quality monitoring reports, (2) notices of upcoming meetings, and (3) access to NYCDEP's GIS data layers.**

Septic Systems

NYCDEP has met the conditions of the 1997 FAD by establishing a mechanism and prioritization scheme to ensure that septic system failures are adequately addressed in the west-of-Hudson watershed. Failing septics are primarily addressed through the Septic System Rehabilitation and Replacement Program. EPA notes that the prioritization scheme set up through the Septic System Rehabilitation and Replacement Program does not include septic systems that will be addressed/remediated through other MOA programs, such as the New Sewage Treatment

Infrastructure Program and Sewer Extension Program. Thus, the ultimate success of the Septic System Rehabilitation and Replacement Program, requires the expeditious implementation of both of these MOA programs.

The failure of septic systems in the New York City watershed is a widespread problem that, prior to the Septic System Rehabilitation and Replacement Program, was not adequately addressed. NYCDEP=s previous strategy for detecting failing systems was unable to discern failure of these systems until the homeowner requested an inspection, or until a neighbor filed a complaint. However, due to the economic incentives in the Septic System Rehabilitation and Replacement Program, inspectors were inundated with inspection requests, and the program became an immediate success. With an estimated 50% of septic systems in the watershed being identified as substandard, the need for septic system rehabilitation/replacements has continued to rise. However, this program has a finite budget that will be exhausted, possibly by the end of this FAD. The operation of failing septic systems within the watershed is unacceptable. **EPA strongly recommends that the City establish an effective, long-term mechanism to detect and remediate failing systems which does not rely on the previous, inadequate detection system. EPA recommends that this system be established prior to the termination of the existing Septic System Rehabilitation and Replacement Program, and that it include Catskill/Delaware watersheds east-of-Hudson.**

The City is spending tens of millions of dollars through several different partnership programs (discussed above) to address the problem of failing septic systems in the watershed. As borne out by the evaluation conducted by the MOA Technical Advisory Committee (TAC) in 1999, there are many factors that could lead to septic failure. The TAC study found that:

- Steeper sloped sites often require sophisticated engineering design/construction techniques,

- The more complicated the design, the higher the likelihood of improper construction and increased reliance on vigilant operation and maintenance (O&M), and

- The majority of septic system failures occur because of improper construction and insufficient O&M.

EPA is currently evaluating outside peer reviewers' comments on the TAC's findings. But with these general findings in mind, EPA believes that it is prudent environmental policy to minimize as much as possible any factor that might add to the risk of failure of newly installed septic systems. **EPA recommends that NYCDEP (with the support of NYSDOH) enforce the plain and unambiguous reading of Appendix 75-A and not allow septic systems on slopes greater than 15% and not allow septic systems that need significant grading for the expressed purpose of reducing the slope to 15%.**

Significant resources have been committed to remediating failed septic systems. Proper operation and maintenance of septic systems, after they have been repaired or rehabilitated, is the most cost-effective approach to assure long-term reliability. **EPA recommends that the City develop a comprehensive program, with appropriate incentives, to ensure proper operation and maintenance of septic systems in the watershed.** One existing incentive is the City=s acceptance (at no cost) of pump-out waste at its new wastewater treatment plants (WWTPs). This activity is important to the immediate and long-term success of the Program. Currently, however, the City is not accepting waste during winter months at certain plants. **EPA recommends that the City and State expeditiously resolve this issue so that City WWTPs can accept pump-out waste on a year-round basis.**

Wastewater Treatment Plant (WWTP) Inspection and Compliance Program

The objectives of the WWTP Inspection and Compliance Program are to ensure compliance with New York State Pollutant Discharge Elimination System (SPDES) permit requirements, and to reduce pollutant loading impacts from municipal and privately owned WWTPs operating in the New York City watershed. Prior to January 1994, only three out of 110 WWTPs discharging in the watershed were classified as significant municipal or industrial facilities, and were tracked in the EPA database for compliance/enforcement purposes. In addition, approximately 70% of SPDES dischargers in the watershed were not required to submit discharge monitoring reports, and were not subject to surveillance oversight by NYSDEC. By January 1994, all NYC watershed facilities east- and west-of-Hudson were elevated, by NYSDEC, to a level equivalent to EPA major status and, therefore, were required to begin submitting discharge monitoring reports. In addition, all WWTPs started to receive routine oversight by NYSDEC and NYCDEP. Since the mid-1990s, there have been numerous enhancements to the WWTP Inspection and Compliance Program; these enhancements are discussed in detail in Chapter VIII.

From 1995 to 1999, “significant non-compliance” (SNC) violations were reduced from a quarterly average of over 30% to 8%. Effluent discharge violations were reduced from 20% to 5%. All current SNC violations are being addressed through formal enforcement actions by NYSDEC and/or NYCDEP. This declining trend in SNC violation rates is a measure of the program’s success to date. EPA considers 0% SNC to be an appropriate and achievable goal, as NYCDEP and NYSDEC continue to work together to implement this enhanced regulatory strategy in the watershed.

Wastewater Treatment Plant Upgrade Program

The Wastewater Treatment Plant Upgrade Program is a key component of the FAD. Upgrades of non-City-owned WWTPs in the watershed will have an immediate water quality impact by eliminating the discharge of pathogens, and significantly reducing the discharge of other pollutants. EPA is

seriously concerned that, based on the information received to date, the City will not comply with the May 2002 upgrade completion date specified in the FAD, the City's Watershed Rules & Regulations (WR&R), and MOA. **EPA strongly recommends that NYCDEP immediately accelerate completion of the Wastewater Treatment Plant Upgrade Program. The City's commitment and ability to complete this Program expeditiously will be a critical factor in determining the future of filtration avoidance. To that end, EPA requests that the City submit an action plan within 60 days which details actions the City will take to get the program back on track.**

EPA notes that the City has completed the upgrades of all City-owned WWTPs within the timeframes specified in the FAD. With these upgrades, approximately 40% of the WWTP effluent discharging into the Catskill/Delaware watershed is now being treated by advanced tertiary treatment (microfiltration).

Project Review/SEQRA

For watershed projects, the City is considered an "involved agency" under the State Environmental Quality Review Act (SEQRA). As such, it has significant power to control environmentally unsound development in the watershed by ensuring that issues it raises during the SEQRA process are adequately addressed prior to a project moving forward. Therefore, coordination and participation in project review under SEQRA are important NYCDEP functions. From EPA's perspective, effective utilization of the City's authority under both SEQRA and the WR&R is necessary to address activities that may adversely impact water quality in the watershed.

Effective utilization of both mechanisms is particularly critical in addressing problems associated with impervious surfaces from large development projects. Reduction of impervious surfaces is a key component of good environmental design. Many studies have shown that there is an "imperviousness" threshold at which no BMPs can mitigate the additional pollutant load resulting from development. In addition, with large development projects, the uncertainties built into stormwater models (which evaluate potential impacts of stormwater runoff) are magnified. Therefore, if the City is not involved early in site design (through SEQRA) and instead waits to address all environmental concerns through the Stormwater Pollution Prevention Plan (SPPP - required under the WR&R), the result will be an SPPP that cannot meet its own objectives (i.e., no net increase in pollutant loadings over pre-existing construction conditions). Through SEQRA, the City should work to reduce the project's footprint during the planning stage --- a much more effective mechanism to reduce stormwater runoff than to rely solely on an SPPP at the end of the development process. With good environmental design, the developer can produce a workable SPPP that reduces total reliance on structural stormwater controls to mitigate pollutant runoff from a site.

While there has been recent improvement in the City's involvement in the SEQRA process, **EPA strongly recommends that NYCDEP play a more consistent, active role at the earliest possible stage of the project planning process. EPA recommends that the City utilize**

experienced environmental land use planners to work with the applicant to limit a project's impervious surface or footprint, and to ensure that environmental concerns are addressed. In addition, EPA recommends that the City:

- **Map, analyze and track impervious cover in the watershed (particularly in east-of-Hudson basins) to better evaluate the thresholds at which the water quality impacts from development may be irreparable;**

- **Support local initiatives (such as upzoning) that may provide a water quality benefit; and**

- **Apply SPPP guidance in a consistent manner.**

Finally, in order to more effectively address water quality concerns, EPA recommends that the Lead Agency under SEQRA ensure that each project applicant initiates the SPPP early in, and on a parallel track with, the project planning process.

Watershed Monitoring and Modeling - Data Analysis/Integration/Dissemination

NYCDEP conducts an extensive water quality monitoring program throughout the watershed, and throughout each of its reservoir basins. In recent years, as a result of its own internal reviews, and as a result of outside assessments, the City has significantly enhanced its monitoring program. Furthermore, the City continues to make improvements. For example, NYCDEP is aggressively developing, evaluating and implementing new analytical methods as part of its pathogen monitoring program. However, a number of issues need to be addressed as the City's watershed protection efforts move from the planning phase into the implementation and analysis phase. In its *Filtration Avoidance Supplemental Annual Report* (November 1999), NYCDEP recognized the importance that statistically-based trend analysis will play in assessing the effectiveness of its watershed management programs. It is paramount that the City have a monitoring network (or networks) robust enough to support rigorous trend analysis at the basin and sub-basin scales. In addition, the City's watershed-wide monitoring network must be fully integrated with other ongoing City and non-City monitoring programs that are at different watershed scales.

The City's *Filtration Avoidance Supplemental Annual Report* provides a conceptual framework for the types of tools that the City plans to use to measure the success of each of its watershed protection programs. For a number of protection programs, the City concludes that the measure of success will be "maintenance of high water quality and consistent compliance with regulations." For remediation programs, the City states that success will be "measured by the degree to which they can reduce pollutant loadings from entering the water supply." EPA agrees that these are appropriate objectives, but the City must take the next step --- to show that the current system is capable of measuring

success. Taking this next step is fundamental to the future of filtration avoidance. **EPA recommends that the City conduct a rigorous analysis of its current monitoring arrays to determine their adequacy to detect trends, and to measure pollutant reductions, within and across watershed programs, at the basin and sub-basin scales. In addition, EPA recommends that the City lay out a specific "roadmap" to show how it intends to utilize these data to measure program success.** This effort may result in an expansion or rearrangement of the City's monitoring program.

Models are one of the key management tools that the City will use to evaluate its watershed programs. They will allow the City to estimate the effectiveness of particular programs and their expected impacts on future water quality. However, to take full advantage of the models, the City must "link" them to its watershed management programs. Linkage, however, requires a better understanding of the effects that local watershed protection/remediation practices have on nutrient concentrations in runoff, and requires the ability to quantify and "scale up" these relationships to the watershed scale. The City's use of terrestrial models as predictive, watershed management tools will be limited unless the effects of management practices and land use changes can be accurately quantified and translated into model input coefficients. **EPA recommends that the City develop a plan for using terrestrial and reservoir models in the watershed to meet program objectives. This plan should ensure the development of accurate runoff and nutrient coefficients for input to the City's terrestrial models, and should provide an enhanced technical basis for future reservoir Total Maximum Daily Loads (TMDLs).**

EPA recognizes that the City collects a tremendous amount of data throughout the watershed. Some of these data have undergone analysis and are presented in FAD deliverables or other reports. However, EPA (as well as other stakeholders) receive very little data or analysis on a number of monitoring programs (e.g., stream and reservoir monitoring). These programs form the foundation of NYCDEP's efforts to determine the long-term effectiveness of its watershed protection and remediation programs. **EPA recommends that the City develop a comprehensive strategy to integrate, analyze and disseminate the data from its watershed monitoring programs. To facilitate this effort, EPA recommends that the City reinstitute its Annual Water Quality Report (last published in 1993), and tailor it to provide analysis that is both programmatic and geographic in scope, addressing specific watershed programs, and the health of individual reservoir basins.**

Total Maximum Daily Load Program

The main FAD objective for the Total Maximum Daily Load (TMDL) Program is to reduce concentrations of phosphorus in the New York City water supply reservoirs to a level necessary to meet Ambient Water Quality Standards. EPA considers that another important objective of the program is to determine if the NYSDEC standard of 20ug/l is sufficient to protect the reservoirs that serve as sources of the City's drinking water supply. The TMDLs in the New York City watershed are being developed in phases. The 1997 FAD contains several milestones for Phase I and Phase II

TMDL development. It outlines commitments made by NYSDEC to establish, and by EPA to take, final Agency action on the TMDLs. The FAD also contains commitments by NYSDEC to modify SPDES permits, as necessary, and to identify potential non-point source management practices to achieve TMDLs.

Although improvements have been made during Phase II, NYCDEP is continuing to refine the models used in TMDL calculations. NYCDEP is scheduled to complete eutrophication models for the west-of-Hudson reservoirs by February 2001. A similar effort has been initiated in the east-of-Hudson reservoirs. With respect to the phosphorus guidance value, NYCDEP provided a technical report to NYSDEC in March 1999 entitled, *Development of a Water Quality Guidance Value for Phase II Total Maximum Daily Loads (TMDLs)*. This report (1) summarizes the work performed to establish a site-specific phosphorus guidance value, (2) reviews the eutrophication-use impairment information, (3) presents an analysis of phosphorus, algal biomass and related water quality parameters and (4) proposes a phosphorus guidance value of 15ug/l for source water reservoirs.

In the FAD, NYSDEC commits to proposing TMDLs within six months of receiving the Reservoir Reports. Due to an extended public comment period and the amount of comments received, NYSDEC has not yet submitted Phase II TMDLs to EPA. **EPA recommends that NYSDEC expeditiously establish and ensure the implementation of Phase II TMDLs for phosphorus in the New York City Watershed. In addition, EPA recommends that NYCDEP work with NYSDEC and local governments to identify specific activities that will reduce non-point sources of phosphorus in basins that not do meet their current, applicable load allocations. Looking to the future, EPA recommends that NYCDEP work with NYSDEC to develop a workplan and schedule for NYSDEC, with City technical support, to establish Phase III TMDLs.**

Catskill/Delaware Water Supply System Filtration Plant

Throughout the first half of the FAD, NYCDEP has complied with the schedule of tasks associated with the design of the Catskill/Delaware filtration plant. EPA is satisfied with the technical adequacy of NYCDEP's design efforts to date. EPA considers the continuation of these efforts to be a prudent measure in the protection of public health. In the event filtration of the Catskill/Delaware supply is deemed necessary, public participation early in the planning process will prove vital to the project's overall success. EPA, therefore, commends NYCDEP in its public outreach efforts through the establishment of the Citizen Advisory Committee.

I. Objective Criteria Compliance

1. Background and Detailed Description of Objective Criteria

The 1986 Safe Drinking Water Act (SDWA) amendments and the 1989 Surface Water Treatment Rule (SWTR) require that all surface water supply sources provide filtration unless the source water quality, disinfection, and site-specific avoidance criteria are met by December 31, 1991. Filtration "avoidance" requires compliance with three rules: (1) SWTR, (2) Total Coliform Rule and (3) Disinfectant and Disinfection Byproducts Rule. These rules are discussed in more detail below.

A. Surface Water Treatment Rule

Source Water Quality Criteria:

- Coliforms - a system must demonstrate that either the fecal coliform concentration is less than 20/100 ml or the total coliform concentration is less than 100/100ml in the water prior to the point of disinfectant application in 90% of the samples taken during the six previous months. A water system which takes fecal coliform readings as well as total coliform readings must use its fecal coliform data to show compliance with this criterion. As a condition of filtration avoidance, the water system must demonstrate that the six month running average (average of all samples taken over the previous six months) of the exceedance of the total or fecal coliform limits is less than or equal to 10%.

- Turbidity Levels - the turbidity of the water prior to disinfection cannot exceed five nephelometric turbidity units (NTUs), on an ongoing basis (sample-by-sample), based on grab samples collected every four hours (or more frequently) or based on continuous monitoring.

Disinfection Criteria:

- Inactivation Requirements - a system must demonstrate that it maintains disinfection conditions which inactivate 99.9% of *Giardia* cysts and 99.99% of viruses every day of operation except any one day each month.

- Demonstration of Maintaining a Chlorine Residual - a system must demonstrate that it maintains a minimum free chlorine residual of 0.2 mg/l entering the distribution system and that it maintains a detectable chlorine residual throughout the distribution system.

- Disinfection System Redundancy - a system must provide uninterrupted disinfection, i.e., redundant components including an auxiliary power supply with automatic start-up and alarm to ensure that disinfectant application is maintained continuously while water is being

delivered to the distribution system.

Site-Specific Criteria:

- Watershed Control - a system must establish and maintain an effective watershed control program to minimize the potential contamination by *Giardia* cysts and viruses in the source water.

- On-site Inspection Requirements - a system must have an annual on-site inspection conducted by the primacy agency which demonstrates that the system is maintaining an adequate watershed control program and reliable disinfection treatment and equipment redundancy. (See Appendix A for the 1999 On-site Inspection Report [which also includes a discussion of Hillview Reservoir operations]. We acknowledge that the City is working with EPA to finalize an enforceable agreement to remediate reservoir gatehouses, to replace operators and to continue closely monitoring the drinking water supply.)

- Absence of Waterborne Disease Outbreaks - a system cannot have been identified as being the source of a waterborne disease outbreak, or if it has been so identified, the system must have been modified sufficiently to prevent another such occurrence.

- Compliance with the Total Coliform Maximum Contaminant Level (MCL) and the requirements of the Total Coliform Rule - a system must comply with the MCL for total coliforms (in the distribution system) in at least 11 out of the previous 12 months the system served water to the public on a continuous basis. See below for more Total Coliform Rule requirements.

- Compliance with the Total Trihalomethane (TTHM) MCL and the requirements of the Disinfectant and Disinfection Byproducts Rule - a system must comply with the MCL for TTHM (in the distribution system) on a quarterly running average basis. See below for more Disinfectant and Disinfection Byproducts Rule requirements.

B. Total Coliform Rule (TCR)

The goal of the TCR, promulgated at the same time as the SWTR, is to protect water supplies from waterborne disease causing organisms by ensuring that the water supplier performs sufficient routine distribution system monitoring of coliform bacteria. The number of routine monthly samples taken is based on the population served by the water system. NYCDEP routinely takes nearly twice the required number of distribution system samples. The rule requires that additional testing be performed if any samples are positive for coliforms, and that the State be notified the same day if fecal coliform or
E. Coli bacteria are found in the drinking water.

The enforceable monthly MCL for total coliform (TC) and E. coli for systems required to take more than 40 samples per month is that for all samples taken, including repeat samples, no more than 5% may be positive for total coliforms. A monthly MCL violation has occurred if more than 5% of the samples are positive for total coliform. (As stated in the SWTR, a system must comply with the MCL for total coliforms in at least 11 out of the previous 12 months to avoid filtration.) An acute MCL violation occurs when a routine distribution system sample is TC positive and either of the following occurs: (1) The original sample is also positive for fecal coliform (FC) or
E. coli and any of the repeat samples is TC positive; or (2) any of the repeat samples are positive for TC and FC or E. coli.

Combined, the SWTR and the TCR provide controls for pathogens in both the source water and the distribution system.

C. Disinfectant and Disinfection Byproducts Rule(D/DBPR) / Stage 1 D/DBPR

Disinfection of drinking water has been shown to be highly effective at protecting public health by virtually eliminating typhoid, cholera and other waterborne epidemics.[2] Use of disinfection, however, must be balanced with the risks associated with consumption of disinfection byproducts such as trihalomethanes (THMs) and haloacetic acids (HAAs). For a system to continue to meet the criteria to avoid filtration under the SWTR, it must comply with the TTHM MCL standard. At the time the 1997 FAD was written, the regulation established an MCL for total THM of 0.10 mg/l for systems serving populations greater than 10,000 such as the New York City system.

The TTHM MCL has been modified as a result of the Stage 1 D/DBPR and compliance is mandatary for NYCDEP by January 1, 2002. The rule revises the MCL for TTHMs from 0.10 mg/l down to 0.08 mg/l and includes a new MCL for the sum of the five haloacetic acids (HAA5): monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. The MCL for HAA5 is set at 0.060 mg/l, and new MCLs are established for bromate (0.010 mg/l) and chlorite (1.0 mg/l). Under the new rule, "a public water system is in compliance with the MCL when the running annual arithmetic average of quarterly averages of all samples, computed quarterly, is less than or equal to the MCL. If the running annual average computed for any quarter exceeds the MCL, the system is out of compliance."[3]

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[2]Stage 1 Disinfectants and Disinfection Byproducts Rule Fact Sheet; Office of Ground Water and Drinking Water; December 1998; http://www.epa.gov/ogwdw/mdbp/dp1.htm

[3]Federal Register: December 16, 1998 (Volume 63, Number 241); Rules and Regulations; From the Federal Register Online via GPO Access (wais.access.gpo.gov)

The requirements listed above are easily quantifiable and are, therefore, collectively known as the Objective Criteria in the FAD. These parameters are included in the SWTR requirements to ensure that drinking water is of sufficient quality to limit incidence of waterborne diseases and other health effects in the general population. The City's compliance with the above rules is of critical importance to maintaining filtration avoidance status.

2. Objective

Provisions of the SWTR require filtration of public water supplies that use surface water unless a number of source water quality criteria and site-specific criteria are met. The criteria in the SWTR are designed to control microbiological contamination in drinking water supplies. The "objective criteria" series of the FAD is designed to track New York City's compliance with all of the source water quality conditions and all of the site-specific conditions of the SWTR except the City's watershed control program (and disease surveillance program) which is the focus of the rest of the FAD.

3. Objective Criteria Assessment

A. FAD Task Compliance

The City reports source water and distribution system monitoring results to EPA and NYSDOH on a monthly basis. Each of the systems (Catskill, Delaware, and Croton) is monitored and reported on separately. EPA evaluates the City's compliance with the FAD by reviewing the deliverables listed in Table I.1.

NYCDEP has complied with all of the conditions of the Objective Criteria submittal requirements of the FAD. The City has demonstrated that the programs and reporting mechanisms it has instituted are sufficient for full assessment of its compliance with FAD objective criteria. This assessment is provided below.

B. Objective Criteria Compliance

Since the inception of the 1997 FAD, NYCDEP has successfully demonstrated that the Objective Criteria for filtration avoidance have been met. The City's strategy to comply with the Objective Criteria tasks (Series 100) of the FAD meets the requirements of the SWTR for unfiltered water supplies. Water quality data analysis shows that fecal coliform levels, turbidity and disinfectant byproduct levels are all within acceptable limits. NYCDEP has never incurred a monthly MCL violation and there have been no acute MCL violations since 1994. The 0.10 mg/l MCL for TTHM

has never been exceeded (see Figure I.3). And finally, distribution system monitoring has shown that adequate (detectable) disinfectant concentrations are being maintained throughout the distribution system in compliance with the requirements for unfiltered systems.

Table I.1 - Objective Criteria Compliance Tasks

FAD Task	Objective Criteria Compliance	Due Date/ Frequency
101	Submit raw water fecal coliform concentration sampling results	monthly (10 days)
102	Submit raw water turbidity sampling results	monthly (10 days)
103	Submit raw water disinfection CT value reports	monthly (10 days)
104	Submit operational reports for Kensico and Hillview disinfection facilities	monthly (10 days)
105a	Submit entry point chlorine residual levels (every 4 hours and the lowest value for the day)	monthly (10 days)
105b	Notify EPA and NYSDOH within 24 hours if chlorine residual falls below 0.2 mg/l entering the distribution system	continuous
105c	Notify EPA and NYSDOH by close of next business day, whether or not the chlorine residual was restored within 4 hours	continuous
106	Submit distribution system disinfection residual reports	monthly (10 days)
107	Submit results of trihalomethane monitoring	quarterly (30 days)
108	Notify EPA and NYSDOH within 24 hours of any suspected waterborne disease outbreak	continuous
109a	Submit results of monthly coliform monitoring in distribution system and comply with reporting requirements in Section 141.71(b)(5)	monthly (10 days)
109b	Notify EPA and NYSDOH by the end of day when a sample tested positive for *E. coli*	continuous
109d	Submit report on efforts to maintain sufficient levels of chlorine throughout the distribution system	semi-annually

FAD Task	Objective Criteria Compliance	Due Date/ Frequency
109e	Submit report on cross connection activities including the number of cross contamination complaints investigated, what actions were taken to address identified cross connections, number of plans reviewed, number of devices installed and inspected	semi-annually

i. Source Water Monitoring - Water quality monitoring is performed at both untreated source water locations (Catskill Lower Effluent Chamber, and Delaware Shaft 18) and treated water locations (Catskill Eastview Connection Chamber, and Delaware Shaft 19). To ensure compliance with the SWTR, source water is analyzed for the parameters and monitoring schedule listed in Table I.2.

Table I.2 - Source Water Monitoring Program

Parameter	Catskill System Locations		Delaware System Locations	
	CAT(LEFF)	CAT(EV)	Del(18)	Del(19)
Turbidity	Continuous 24 Hr.	Continuous 24 Hr.	Continuous 24 Hr.	Continuous 24 Hr.
pH	Daily Grab	Continuous 24 Hr.	Daily Grab	Continuous 24 Hr.
Free Chlorine Residual	N/A	Continuous 24 Hr.	N/A	Continuous 24 Hr.
Total Coliform	Daily Grab	Daily Grab	Daily Grab	Daily Grab
Fecal coliform	Daily Grab	Daily Grab	Daily Grab	Daily Grab
Temperature	Daily Grab	Continuous 24 Hr.	Daily Grab	Continuous 24 Hr.

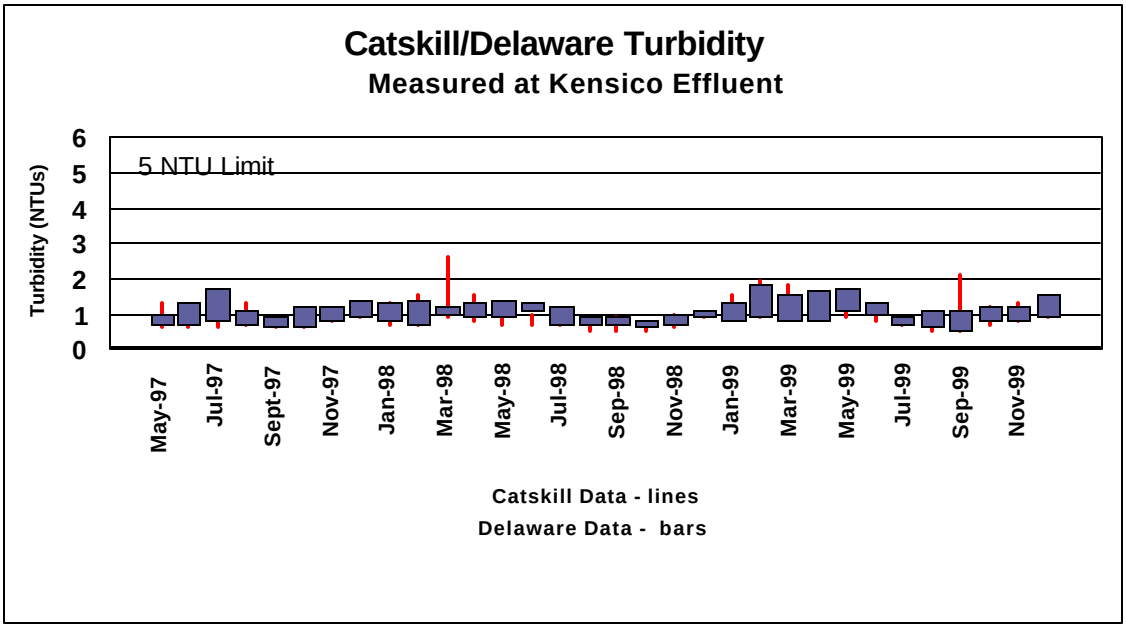
Source Water Turbidity

Excessive turbidity, or cloudiness, in drinking water may represent a health concern.[4] Particles of turbidity provide shelter for microbes and interfere with removal or inactivation processes. It is for these reasons that maximum turbidity levels are prescribed for filtered and unfiltered drinking water.

[4]Guidance Manual for Compliance with the SWTR, Oct 1990.

Figure I.1 shows monthly source water turbidity ranges measured at Catskill and Delaware aqueduct effluents from the Kensico Reservoir. The plot shows that source water turbidities are well below the NTU requirement for unfiltered water supplies.

Figure I.1 - Source Water Turbidity



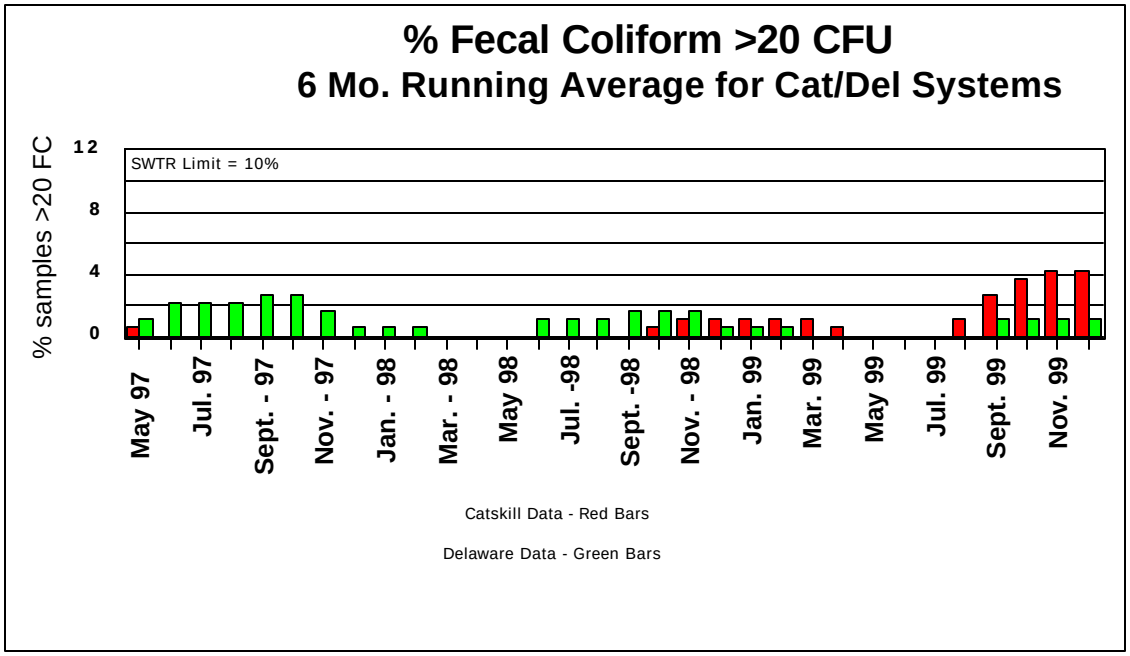
Raw Water Coliforms

Coliform bacteria are an indicator that water may be contaminated with organisms that can cause disease. They are easily tested for and are therefore a good surrogate test parameter for fecal contamination.

Since NYCDEP collects both TC and FC data, it is required to meet the FC limit of 20/100ml only. Total coliform data is collected for informational purposes only and FAD compliance is not dependent

on it. FC data collected since the FAD was issued shows that the six month running average for both the Catskill and the Delaware source water is well below the 10% maximum allowable exceedance of the 20/100ml standard over a six month running average (see Figure I.2). Both Catskill and Delaware water exhibited very low monthly averages. For two periods, the six month running average was reduced to zero: March through May 1998, and May through July 1999.

Figure I.2 - Source Water Fecal Coliform



ii. Raw Water Disinfection - An unfiltered system must demonstrate that it maintains disinfection conditions which inactivate 99.9% of *giardia* cysts and 99.99% of viruses every day of operation except for one day per month. It is considered a violation of a treatment technique if disinfection provides less than this level of inactivation more than one day within a month. If the system incurs such a violation for two consecutive months, then the system must install filtration, unless the situation was caused by unusual and unpredictive circumstances.

In order to determine compliance with this portion of the Rule, NYCDEP calculates and reports "CT." CT is the product of the concentration of the disinfectant (C), in this case chlorine, and contact or exposure time (T) on a monthly basis. To comply with inactivation reporting requirements, the City must calculate CT values during peak hourly flow once each day that it is delivering water to its customers; it must also collect pH and temperature data to determine the required CT for those conditions for effective disinfection. The inactivation ratio (I/R) is the sum of the CT ratios (calculated over required) for each segment of the water treatment process prior to entry to the City's distribution system or the first drinking water tap. NYCDEP must calculate I/Rs and it must ensure that the system's total I/R is greater than 1.0 for a point prior to or at the closest consumer tap (which has the shortest contact time). Both the Catskill system and the Delaware system have three segments over which to reach an inactivation ratio of 1.0. Inactivation ratios have been maintained at greater than 1.0 for the Catskill/Delaware system, satisfying this SWTR and FAD requirement.

iii. Distribution System Monitoring

Coliform Bacteria

NYCDEP has never incurred a SWTR violation or monthly MCL violation, and there has not been an acute MCL violation since 1994. In accordance with the TCR (enforcement of which is delegated to the New York State Department of Health), the City must take a minimum of 480 samples per month to determine compliance with the TCR and SWTR. ("Compliance" sampling sites are located on distribution mains 20 inches in diameter or less which serve water directly to consumers.) In fact, NYCDEP takes approximately 960 samples/month for compliance purposes. In addition, it takes approximately 350 surveillance samples/month throughout the distribution system. ("Surveillance" samples are collected from reservoirs, shafts, pumping stations, trunk mains [with no direct service connections] and wells within the distribution system.) They are not used for compliance purposes but rather supplement information from the compliance locations to aid in detecting problems and taking preventive actions. As detailed in the City's latest Site Sampling Plan (1999), the total number of compliance and surveillance sampling locations are 288 and 222, respectively. The City also conducts sampling at each of the entry points to the distribution system: Shaft 7 for Tunnel No. 1, Shaft 3A for Tunnel No. 2, and Shaft 3B for Tunnel No. 3. (See page 18 of Appendix A [EPA's *1999 Annual On-site Inspection Report*] for monthly coliform results.)

Disinfection Residual

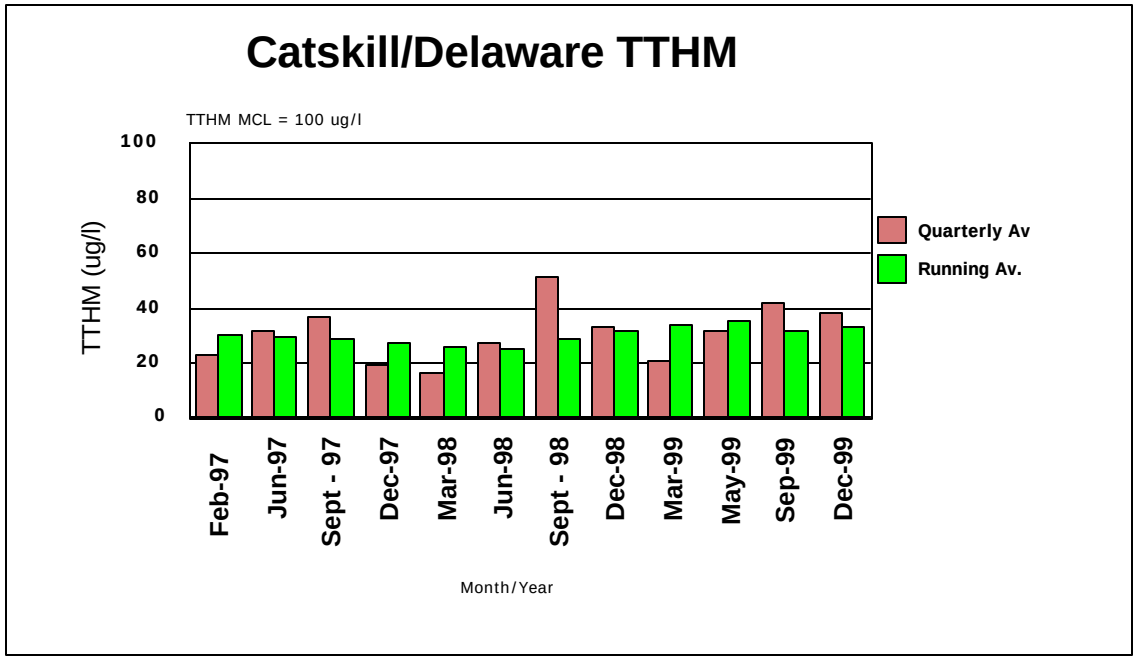
The SWTR disinfection criteria require a system to demonstrate that it maintains a minimum free chlorine residual of 0.2 mg/l entering the distribution system and that it maintains a detectable chlorine residual throughout the distribution system in greater than or equal to 95% of the samples taken each month. If an unfiltered system fails to meet the disinfection requirements for any two consecutive

months, it would be in violation of a treatment technique requirement and it would be required to filter. In accordance with the SWTR, the City must monitor for the presence of a disinfectant residual at the same frequency and locations as total coliform measurements pursuant to the TCR (see above). The City's disinfection strategy ensures compliance with the above criteria, and it as demonstrated by its entry point chorine residual levels and chlorine residual data or heterotrophic plate count (HPC) data throughout the distribution system. (A HPC result may be substituted for free chlorine residual readings. A HPC result that is less than or equal to 500 colonies per ml is considered to be equivalent to a detectable free chlorine reading.)

Trihalomethanes

The Disinfection Byproducts Rule requires that for a system of New York City's size, four samples be taken per quarter. (NYCDEP takes 16 Catskill/Delaware samples.) The Rule also requires that at least 25% of the samples analyzed for TTHM be taken at locations within the distribution system reflecting the maximum residence time of the water in the system. The remaining 75% shall be taken at representative locations in the distribution system, taking into account the number of persons served, different sources of water, and different treatment methods employed. Compliance with the MCL is determined based on a running annual average of quarterly samples collected by the system. If the average of samples covering any 12 month period exceeds the MCL of 0.1 mg/l (100 ug/l) a violation has occurred and NYSDOH, EPA and the public are to be notified. The City reports TTHM levels for the combined Catskill/Delaware distribution system water on a quarterly basis. The City reports quarterly minimum, quarterly maximum, quarterly average, and system quarterly running average levels. Figure I.3 shows the TTHM quarterly average and running averages for the period from February 1997 through December 1999. TTHM levels were well below the MCL of 100 ug/l during this period, and the MCL has never been violated; thus the City is meeting this requirement of the FAD.

Figure I.3 - Total Trihalomethanes in the Distribution System



C. Conclusions/Recommendations

The City has satisfactorily met the Objective Criteria of the FAD to date. It has not incurred an acute violation of the TCR since 1994. **EPA recommends that NYCDEP remain vigilant in its programs to maintain compliance with the Objective Criteria.**

Federal drinking water regulations are evolving as we learn more about constituents of drinking water such as TTHM, HAA, and *Cryptosporidium*. In addition to the current filtration avoidance criteria in the SWTR and the new criteria in the Interim Enhanced SWTR (effective 2002), EPA has an advisory committee discussing future DBP and surface water treatment requirements. The Advisory Committee, chartered under the Federal Advisory Committee Act, includes a member representing large unfiltered systems. The Committee will be discussing, and may recommend, additional filtration avoidance criteria. Any new criteria may have to be met as early as May 2005 (based on these rules being finalized in May 2002). **If new criteria are promulgated, EPA and New York City will need to address those criteria as part of any future filtration avoidance determination.**

NYCDEP maintains a qualified professional science and engineering staff to anticipate and understand potential new rule changes that may impact monitoring and water quality control components of the FAD. NYCDEP personnel actively participate on workgroups formed by EPA to address drinking water rule revisions. **EPA recommends that the City continue to participate on drinking water workgroups and to develop water supply management strategies in anticipation of upcoming**

rule changes.

EPA recommends that the City institute the "summary of needed improvements" highlighted in EPA's *1999 Annual On-site Inspection Report*, which is also included in this Report as Appendix A.

4. Assessment of Ancillary Programs

In support of the Objective Criteria requirements of the SWTR, the FAD requires that the City implement two programs to prevent contamination of the drinking water supply through the distribution system: the **Low Chlorine Residual Remediation Program** and the **Cross Connection Control Program**.

A. Low Chlorine Residual Remediation Program

In order to address the disinfection criteria of the SWTR, and to limit the possibility of bacterial regrowth in the distribution system, the City injects chlorine as a disinfectant on a continuous basis into the distribution system. NYCDEP incurred eight acute TCR violations in 1993 and 1994. The distribution system and Hillview Reservoir were identified as having a potential role in those violations.[5] In response, NYCDEP initiated, among other things, the Low Chlorine Residual Remediation Program. This program was included in the 1997 FAD so that EPA could track free residual chlorine levels at all compliance and surveillance sampling stations to ensure compliance with the disinfection criteria of the SWTR and the Total Coliform Rule.

i. FAD Compliance - FAD Task 109d requires NYCDEP to submit semi-annual reports providing the status of the ongoing system-wide efforts to maintain sufficient levels of chlorine throughout the distribution system to prevent low chlorine residual/total coliform positive areas. Implementation is ongoing and reported on as required by the FAD.

ii. Implementation Assessment - The City uses three approaches to maintain acceptable free chlorine levels at all compliance and surveillance sampling locations:

- It maintains chlorination levels at the distribution system's three entry points at levels sufficient to ensure detectable chlorine levels remain throughout the distribution system. To maintain sufficient chlorination levels, NYCDEP adds chlorine as water leaves Hillview Reservoir. Grab samples for chlorine residuals are taken monthly at City Tunnels Number 1 (sample station

[5] FAD deliverable, 109d, January 1995; Status Report - Low Chlorine Residual Remediation Program Quarterly Report. Since then, NYCDEP has detected both coliforms and E. coli (no violations) at relatively high free chlorine residual levels, indicating no obvious correlation. Chlorine residual levels have been maintained at acceptable levels at almost all sample locations in recent years.

BX4 - Shaft 7), Number 2 (sample station BX5 - Shaft 3A), and Number 3 (sample station 15450 - Shaft 3B). Free chlorine residual has been maintained at or above 0.68 ppm since the inception of the FAD.

- It instituted a "Hot Spot" flushing program to eliminate low chlorine residuals in the distribution system. "Hot Spot" flushing consists of flushing locations that experience low chlorine residual concentrations. The "Hot Spot" flushing locations changed periodically based on conditions in the distribution system. The program was discontinued when other NYCDEP chlorine enhancement program strategies (such as enhanced chlorination at entry points) produced favorable chlorine residual concentrations throughout the distribution system without the need for chlorine flushing.

- The City provides local chlorination booster stations at remote locations. In addition to maintaining sufficient free chlorine residual at the entry points to the three tunnels, NYCDEP also continuously operates three permanent local chlorine booster stations. The booster stations serve the following areas of the City's distribution system which had been previously determined to be potential areas of low chlorine residual:

    1) Fort Tilden, Roxbury and Breezy Point areas of the Rockaway Peninsula of Queens,
    2) City Island in the Bronx, and
    3) Floyd Bennett Field in Brooklyn.

NYCDEP developed a computer generated water quality model of the distribution system in order to assist in water quality control. The future use goals of the model are to trace water movement through the network, trace dispersal of species throughout the network, and to estimate water quality degradation using the concept of water age.

iii. Water Quality Assessment - The implementation of this program has eliminated the need for "hot spot" flushing and it has minimized the incidence of low chlorine residual measurements in the distribution system. The program is now referred to as the "chlorine enhancement program" reflecting the improvements that have been made since the summer of 1993. Though the City has never violated the disinfection residual requirements of the SWTR, it has on occasion experienced low chlorine residual readings in the distribution system. The institution of the Low Chlorine Residual Program has been effective at eliminating low chlorine residual areas. Recent samples collected for determining chlorine residual levels in the distribution system contained an adequate level of chlorine (or low enough HPC) to meet the requirements of the FAD and of the SWTR's unfiltered water system requirements. NYCDEP reports on and provides explanation for any sites with low chlorine residual due to special circumstances (e.g., a main is shut down for construction purposes).

iv. Conclusions/Recommendations - The Low Chlorine Residual Remediation Program has been

successful at meeting its goals. Chlorine residuals have been detectable at all the compliance and surveillance sampling locations. In addition to maintaining sufficient chlorine residual throughout the distribution system, NYCDEP continues to evaluate its distribution system so that it can continue to fine tune chlorine addition to maximize disinfection while minimizing disinfection byproduct production. It has developed a computer generated water quality model of the distribution system for this purpose. **EPA recommends that NYCDEP continue to refine and calibrate the distribution system model so that it may be used for analysis of water quality variations throughout the distribution system. In addition, EPA recommends that the model be used to fine tune the amount of chlorine NYCDEP adds at entry and booster chlorination points to maximize disinfection while minimizing formation of disinfection byproducts.**[6]

B. Cross Connection Control Program

Cross connections in a drinking water distribution system are a potential source of contamination. Cross connections can be caused by improper indirect or direct connections, excessive back pressure on the system, back siphonage, and other reasons. It is important to eliminate any areas where such conditions exist in order to eliminate the possibility for cross connection contamination. The purpose of the City's Cross Connection Control Program is to address this concern

i. FAD Compliance - NYCDEP submits reports on a semi-annual basis (Task 109e) summarizing cross connection program activities including the number of cross contamination complaints investigated, what actions were taken to address identified cross connections, the number of plans reviewed for cross connection prevention devices, the number of devices installed, and the number of devices inspected.

ii. Implementation Assessment - The City's strategy for implementing this program is to (1) investigate any cross connection contamination complaints received (2) remediate any confirmed cross connections, and (3) install and inspect cross connection prevention devices. Implementation of the strategy has been successful at meeting the goals of this program. A Cross Connection Control Task Force, which includes representatives of the plumbing industry, the real estate industry, the engineering community and NYCDEP meets on a monthly basis to define the direction of the Cross Connection Control Program.[7]

[6]NYCDEP Deliverable #609; Development of Distribution System Model; June 28, 1995

[7]NYCDEP, FAD Deliverable 109e; Cross Connection Control Program Semi-annual Report, Dec.31, 1999

NYCDEP keeps track of the number of hospitals or medical centers in New York, how many service connections they have, and how many of these service connections are fitted with backflow prevention devices. The City follows up with those hospitals and medical centers that do not have the required devices by sending letters advising them of the requirement for backflow prevention. NYCDEP has started to inspect water and wastewater transmission and treatment facilities in order to determine their need for backflow preventors. NYCDEP keeps track of the number of waterworks facilities, how many of these facilities have water service lines and how many of these are fitted with backflow prevention devices. During the upcoming year, the City plans to re-inspect funeral homes and mortuaries to measure the degree of compliance with cross connection requirements.

In addition, the NYCDEP receives complaints about and investigates possible cross connections in the distribution system.

iii. Conclusions/Recommendations - The City has an active Cross Connection Control Program which adequately addresses EPA's concern about potential cross connection contamination in the distribution system. A mechanism to address potential complaints and to inspect all facilities that may have cross connections is currently in place. **EPA recommends that the City give high priority to follow-up work on back flow prevention device inspections and cross contamination complaints in order to eliminate any sources of cross connection contamination as soon as practicable.**

II. Disease Surveillance Program

1. Objectives

The overall objective of the Disease Surveillance Program is to track the incidence of and gather relevant epidemiological data on two waterborne diseases: giardiasis and cryptosporidiosis. Central goals of the City's Disease Surveillance Program include tracking the incidence of disease, and developing and maintaining a system to detect disease outbreaks of possible waterborne transmission. It is important to understand the endemic rates for giardiasis and cryptosporidiosis and any possible association between these diseases and the New York City water supply so that appropriate steps may be taken by health care professionals and water supply consumers. Knowledge of endemic waterborne disease rates may also aid NYCDEP in making risk management decisions. Early detection of an outbreak may prevent disease from occurring on a widespread basis, and it will limit the spread of the disease before it reaches epidemic proportions. As a condition of filtration avoidance, in accordance with the Surface Water Treatment Rule, a public utility must demonstrate that it has not been the source of a waterborne disease outbreak.

2. Background and Program Description

Giardia and *Cryptosporidium* are waterborne pathogens present in surface water supplies world-wide. They are more resistant to current disinfection methods than other pathogens. Giardiasis and cryptosporidiosis are intestinal illnesses caused by these microscopic organisms that can live in the intestines of humans and animals. *Giardia* is considered one of the most common causes of waterborne disease epidemics in the United States, in terms of both the number of outbreaks and the number of persons affected. The extent of endemic, or non-outbreak related giardiasis, and the risk factors for endemic transmission has not been fully described, partly because the disease has only recently been considered a "reportable disease" in many states, including New York.

The 1993 Milwaukee outbreak of cryptosporidiosis, which affected more than 400,000 persons, highlighted the importance of tracking this disease. The *Cryptosporidium* parasite is protected by an outer shell (oocyst) that allows it to survive outside the body for a long period of time and makes it very resistant to chlorination. Since New York City drinking water is from an unfiltered surface water supply, it is especially important for NYCDEP to monitor for the presence of these organisms and any outbreaks of waterborne disease. Very low levels of *Cryptosporidium* have been detected periodically in water leaving Kensico Reservoir, just before it enters the New York City drinking water supply. There is also considerable evidence that low level (non-epidemic) transmission of *Cryptosporidium* species through drinking water may be occurring throughout the United States. Currently, the health risks associated with drinking filtered or unfiltered tap water containing trace quantities of *Cryptosporidium* oocysts is unknown. It is for these reasons that detection of

Cryptosporidium in drinking water supplies and active disease surveillance for cryptosporidiosis has been a recent focus of water suppliers across the United States.

Adoption of a New York City Health Code amendment made cryptosporidiosis a reportable disease in New York City in 1993; subsequently, New York City started active disease surveillance for giardiasis in July 1993 and cryptosporidiosis in November 1994. As a condition of the 1993 FAD, the City was required to meet two conditions by March 1994:

- Ensure that the active disease surveillance program is adequate for tracking the incidence of and gathering relevant epidemiological data on giardiasis and cryptosporidiosis for the ultimate purpose of determining the endemic rates of these diseases, and

- Convene an expert panel to advise New York City on determining the relationship between drinking water and any occurrence of giardiasis and cryptosporidiosis in the City and to review the City's Active Disease Surveillance Program and its findings.

As required by the 1993 FAD, in March 1994, NYCDEP convened an advisory panel to provide guidance on the assessment of waterborne disease risk in New York City. The advisory panel produced a report on October 7, 1994 with the following recommendations for program improvements[8]:

- Designate a full time Waterborne Disease Coordinator – to be responsible for waterborne disease surveillance activities and to field all relevant water-related complaints and health department inquiries;

- Report and analyze disease surveillance data – using surveillance of laboratory data provided to NYSDOH;

- Consider waterborne disease surveillance studies – for improving the detection and early recognition of waterborne disease;

- Improve levels *Cryptosporidium* reporting – by educating physicians and health care workers about the disease and testing methods, and by encouraging laboratories to examine stool samples for *Cryptosporidium*; and

- Evaluate the waterborne disease surveillance program annually – to determine if

[8] *Report of New York City's Advisory Panel on Waterborne Disease Assessment* (October 1994)

the program is effective for the detection and early recognition of waterborne disease outbreaks or is otherwise valuable for waterborne disease risk assessment.

The 1993 FAD conditions were satisfactorily met by the City. NYCDEP has incorporated many of the panel's recommendations into its current program. The specific objectives of the Disease Surveillance Program component of the 1997 FAD are to:

- Continue implementation of the active disease surveillance program in order to attempt to establish the endemic rates of cryptosporidiosis and giardiasis in New York City;
- Monitor for disease outbreak of cryptosporidiosis and giardiasis in New York City;
- Determine if a relationship exists between the City's drinking water and any incidence of giardiasis or cryptosporidiosis; and
- Report on disease surveillance findings on a quarterly and semi-annual basis.

In 1999, the National Research Council (NRC) released its report on the status of the Watershed MOA which included a section on Disease Surveillance and Public Health Protection. The NRC report contained several conclusions and recommendations which have been considered in the writing of this review.[9] In addition, as part of EPA's mid-course FAD evaluation, several public meetings were held at which several commenters provided input on the City's Disease Surveillance Program.

3. Assessment

A. FAD Task Compliance

The City is responsible for producing quarterly status reports on its Active Disease Surveillance Program and semi-annual updates on the status of its Drinking Water Quality Waterborne Disease Program (see Table II.1). The City has submitted all required reports on a timely basis since the inception of the program. In addition, the City gives annual presentations on the Waterborne Disease Risk Assessment Program. In summation, the City has been successful at meeting its program and compliance objectives.

[9] *Watershed Management for Potable Water Supply: Assessing New York City's Approach* (National Academy Press - prepublication copy 1999).

Table II.1 - FAD Task Requirements

FAD Task	Disease Surveillance	Reporting Frequency
701a	Continue implementation of active disease surveillance program for tracking incidence of and gathering relevant epidemiological data on giardiasis and cryptosporidiosis	ongoing
703a	Submit reports on the status of the Active Disease Surveillance Program for giardiasis and cryptosporidiosis	quarterly
704	Provide updates on status of the Drinking Water Quality Waterborne Disease Program projects and its activities	semi-annually

B. Implementation Assessment

New York City's Waterborne Disease Risk Assessment Program was established to: (1) obtain relevant data on the rates of giardiasis and cryptosporidiosis, along with demographic and risk factor information on case patients, (2) provide a system to track diarrheal illness to assure rapid detection of any outbreaks, and (3) determine the contribution of tap water consumption to gastrointestinal disease. The program, jointly administered by the New York City Departments of Health and Environmental Protection, began in 1993. The City formed an interagency unit, the Parasitic Disease Surveillance Unit to implement major components of the program. The City's strategy to address the specific objectives of the 1997 FAD includes the following:

- Continue with *active disease surveillance* for giardiasis and cryptosporidiosis;
- Continue with sentinel surveillance for *waterborne disease outbreak detection;*
- Obtain risk exposure information and design and conduct *epidemiological studies*; and

- Engage in *educational outreach* to health care facilities and make presentations at local and international professional conferences.

Below is a more detailed discussion, with recommendations, on each of the four elements of the City's strategy. Also included is a short discussion on risk assessment.

i. Active Disease Surveillance

Active Disease Surveillance for giardiasis has been ongoing since the City implemented the program in July 1993. The program improves upon the passive surveillance program, which had been in place since 1986, by collecting more accurate and comprehensive data on disease occurrence and risk factors. All clinical laboratories certified for parasitology in the New York City area are contacted regularly to solicit reports on all positive specimens for *Giardia lamblia* and *Cryptosporidium*. In addition, telephone calls are made to physicians, laboratories, and patients to obtain missing demographic information from case reports. The number of cases found and case rates calculated from data (1994 - 1998) on giardiasis and cryptosporidiosis are included in Table II.2.

Table II.2 - Case Rates for Giardiasis and Cryptosporidiosis

Year	Number of Cases Giardiasis	Case Rate Giardia per 100,000	Number of Cases Cryptosporidiosis	Case Rate Crypto per 100,000
1994	2,456	33.5	289**	3.9**
1995	2,485	33.9	472	6.5
1996	2,289	31.2	332	4.5
1997	1,764	24.1	174	2.4
1998	1,964	26.8	209	2.9
1999	1,765*	24.1*	261*	3.6*

*Preliminary data for 1999 (as of January 13, 2000)

** Active Disease Surveillance began in November 1994

Case rates for both giardiasis and cryptosporidiosis have shown a steady decline between 1995 and 1997. The number of cases of giardiasis and cryptosporidiosis reported in 1998 increased as compared with 1997, but is still lower than in past years. The City found that the decline in

cryptosporidiosis observed between 1995 and 1996 was due to a decline in cases among persons with HIV/AIDS. The City determined that the case rate of cryptosporidiosis among persons with AIDS declined from 1.5/100 persons in 1995 to 0.2/100 persons in 1998.

Three factors can lead to the significant under-diagnosing of cryptosporidiosis: (1) people with cryptosporidiosis may not seek medical care during the course of the disease, (2) most physicians do not order an ova and parasite test for each of their patients with gastrointestinal disease, and (3) many laboratories that perform ova and parasite testing do not test for cryptosporidiosis routinely. Another complicating factor is that there is a greater likelihood of diagnosing cryptosporidiosis in HIV-infected persons than in HIV-negative persons since cryptosporidiosis is an AIDS-defining illness. Therefore, it is more likely that stool samples from HIV-infected persons will be submitted for cryptosporidiosis testing. While the City has been working with health care professionals to enhance gastro-intestinal disease reporting, it has not formulated a relationship between reported cases and non-reported cases of cryptosporidiosis and giardiasis in NYC that might help evaluate the extent of occurrence of these diseases.

In 1995, to supplement the Active Disease Surveillance Program, the City initiated a pilot program in cooperation with New York City DOH's Bureau of Laboratories. All stool specimens sent by Child Health Clinics, which serve 80,000 children, are tested for *cryptosporidium*. Results of this study show the prevalence of *cryptosporidium* in children to be 0.09% for 1996, 0% for 1997, 0.05% for 1998, and 0 for 1999. Efforts such as this pilot program are useful in supplementing the information attained from the baseline Active Disease Surveillance Program.

Conclusions/Recommendations - The City has shown through active disease surveillance that it can determine disease rates for cryptosporidiosis and giardiasis. Although active disease surveillance is subject to under-reporting, it is an important element of the City's multi-tiered Disease Surveillance Program. **EPA recommends the continuation of the City's active disease surveillance program. NYCDEP should actively encourage both physicians and laboratories to use stool testing for *Cryptosporidium* in an attempt to increase the reporting of this disease. Furthermore, EPA recommends that the City increase the number of laboratories monitored as more laboratories undertake cryptosporidiosis analysis. Finally, EPA recommends that the City continue to seek new methods of determining incidence of both endemic and epidemic cryptosporidiosis in New York City.**

ii. Outbreak Detection Program

The monitoring of gastrointestinal illness in the general population can provide an early indication of an impending or developing waterborne disease outbreak. A well-designed Outbreak Detection Program can limit illnesses and mortality associated with gastrointestinal disease. The surveillance system should be sensitive enough to detect a potential problem early enough to prevent illness on a massive scale.

The City engages in three independent and complementary systems to monitor for disease outbreaks. It reports that these three systems did not detect any waterborne outbreaks since outbreak detection began. The following is a discussion of the three systems.

Anti-diarrheal Medication Monitoring

This sentinel program provides valuable information on the amount of diarrheal illness in New York City. Because people with gastrointestinal disease often self medicate, either prior to a doctor's visit or instead of one, marked increases of anti-diarrheal medication sales is an indicator that a gastrointestinal disease outbreak may be underway in the represented area.

The City utilizes two sources of sales information to track sales of anti-diarrheal medication: a regional drug distributor and a chain of drugstores. Since 1995, the largest metropolitan distributor of drugs provides information to the City on weekly sales of Imodium® to independent pharmacies. These data include shipments to approximately one third of all pharmacies located in New York City. After over three and a half years of monitoring, NYCDEP has detected an apparent annual pattern: a decrease in shipments occurring in late October-early November, followed by small increases or decreases over other periods of time during the year. In addition, since 1996, NYCDEP has been receiving weekly anti-diarrheal medicine sales reports from a chain of 38 drugstores located throughout all boroughs in New York City. The profile of drug sales from these reports shows an annual decrease in sales in November, which coincides closely with the drug distributor data.

Anti-diarrheal medication monitoring is one method of determining the average or background level of sales traffic of this product in the City. Having established the typical background fluctuation in drug sales and distribution, NYCDEP is able to detect any unusually high sales traffic of these medications. An atypical fluctuation could indicate that an increase in waterborne or other route-transmitted gastrointestinal disease, or that a sales promotion, has occurred. If an atypical fluctuation is detected, the City routinely determines the cause.

Clinical Laboratory Monitoring

Clinical laboratories accept stool samples from both hospitals and physicians' offices when stool sample testing is ordered by physicians to test for parasitic disease. Starting in 1995, the number of stool specimens examined for (a) bacterial culture and sensitivity (three laboratories), (b) ova and parasites (three laboratories), and (c) *Cryptosporidium parvum* (one laboratory) is transmitted to the City's Parasitic Disease Surveillance Unit by fax. A total of three clinical laboratories participate in this program.

The number of stool specimens submitted to clinical laboratories for microbiological testing provides information on the prevalence of gastrointestinal illness in the City. However, since many cases of cryptosporidiosis are asymptomatic, or are present with only mild symptoms, and since stool sample

testing for cryptosporidiosis requires that a specific test be ordered, it is likely that laboratory reporting will underestimate the actual incidence of cryptosporidiosis in the population. This type of information is very useful, however, for the City's Outbreak Detection Program. Three factors, in particular, can lead to the significant under-diagnosing of cryptosporidiosis: (1) people with cryptosporidiosis may not seek medical care during the course of the disease, (2) most physicians do not order an ova and parasite test for each of their patients with gastrointestinal disease, and (3) many laboratories that perform ova and parasite testing do not test for cryptosporidiosis routinely. Another complicating factor is that there is a greater likelihood of diagnosing cryptosporidiosis in HIV-infected persons than in HIV-negative persons since cryptosporidiosis is an AIDS-defining illness. Therefore, it is more likely that stool samples from HIV-infected persons will be submitted for cryptosporidiosis testing.

Nursing Home Monitoring

Nursing home surveillance began in 1997 with 11 nursing homes; all five boroughs are represented. Each nursing home facility varied by type of resident (elderly, AIDS, and a combination of elderly and AIDS) and by type of water served (bottled, tap, or filtered). Participating nursing homes provide daily information to the City, by fax, on the number of new gastrointestinal illnesses detected. The City maintains information on the population of each of the facilities as well as the type of water used. The surveillance program indicates a low incidence of gastrointestinal illness. Analysis of the data also showed a small bacterial non-waterborne disease outbreak at one of the sentinel nursing homes in 1997.

Conclusions/Recommendations - The City's Outbreak Detection Program is to be commended. New York City is breaking ground in this still developing field. Some of its program elements have been featured in a Centers for Disease Control and Prevention (CDC) manual, *Cryptosporidium and Water: A Public Health Handbook* (1997). Still, there are limitations to disease outbreak detection. For example, some peaks in diarrheal medicine sales have been shown to be caused by sales promotions of diarrheal medications. It is also difficult to determine the source of identified diarrheal disease, whether it be from food, New York City drinking water, or other causes. To combat these limitations, the City collects data from three different surveillance sources enabling it to detect trends across surveillance programs. **EPA supports the City's approach to outbreak detection and recommends that it continue to analyze data to detect trends indicating increased rates of disease. EPA recommends that NYCDEP determine the sensitivity of its Outbreak Detection Program.**

EPA recommends that the City continue to seek new methods of determining incidence of both endemic and epidemic cryptosporidiosis in New York City. Towards this effort, EPA recommends that the City increase the number of laboratories monitored as more laboratories undertake cryptosporidiosis analysis.

iii. Epidemiological Studies

As part of its active disease surveillance efforts, the City has collected significant risk exposure information during case interviews. This information provides clues as to risk factors for disease; however, it does not provide any conclusive evidence about their associations. To address this data gap, in 1995, the City embarked on two epidemiological studies aimed at determining the relationship between risk factors (e.g., drinking water) and incidence of cryptosporidiosis and giardiasis.

Giardiasis Case-Control Study

A case-control study is an observational study in which a group of subjects (in this example, people) with a known disease (cases) and a group of subjects without that disease (controls) are identified, without prior knowledge of exposure or other risk factor information, and are compared with respect to exposure and other risk factor history.[10] In 1995, the City began work on a case-control study of giardiasis to assess risk factors for the disease in the general population. Cases were selected from the active disease surveillance program database which includes all laboratory-confirmed cases of giardiasis. For this study, cases were defined to be persons from the database with three or more stools within a 24-hour period for at least three consecutive days. Controls were selected using a random selection method and were matched to cases by sex, age group, and by language of interview.

Of the 295 subjects identified by active disease surveillance and included in the database, only 120 (40.7%) of their respective cases met the stool criteria defined by the study. Using univariate analysis, the association of illness with the following risk factors was examined:

- presence of a self-reported immuno-suppressing condition,
- other household members with diarrhea,
- gardening/handling dirt,
- recent travel within the US,
- travel to Puerto Rico or outside the United States,
- drinking New York City tap water,
- drinking water directly from a lake or stream,
- swimming in fresh water or a swimming pool,
- eating at restaurants or salad bars, and
- playing with animals.

Of all the risk factors considered, the strongest risk association was the presence of a self-reported immuno-suppressing condition. Case subjects were found to be 13.5 times more likely than controls to

[10] Evelyn O. Talbott, Gunther F. Craun, Eds., *Introduction to Environmental Epidemiology* (Lewis Publishers 1995) p. 50.

have decreased functioning of their immune systems. In addition, in the 30 days before illness, case subjects were less likely to have anyone in the household with diarrhea and less likely to garden or handle dirt compared to control subjects.[11] Because the case and control group sizes were small, the study was not able to determine the relationship, if any, between New York City drinking water and giardiasis. Though inconclusive, valuable information on giardiasis was collected and EPA looks forward to receiving the final report of this study.

Cryptosporidiosis Cross-Sectional Study

A cross-sectional study is another type of observational study, "usually a survey, which at the same point in time jointly classifies persons relative to disease status and exposure status."[12] From October 1995 to July 1997, a cross-sectional study was conducted to determine the prevalence of current infection and past exposure to *Cryptosporidium* among HIV-infected persons in New York City. The study was meant to assess the association between cryptosporidial infection and various risk factors, including consumption of New York City drinking water. The study was conducted by Dr. R. Soave at the New York Hospital-Cornell Medical Center, in collaboration with the New York City Department of Health, and funded by the CDC and NYCDEP.

Four hundred and five HIV positive patients of The New York Hospital-Cornell Medical Center were included in the study. Each patient submitted a stool sample and serum specimens, and were verbally administered a 17 page survey to obtain information on various risk factors including: sources of drinking water, exposure to surface or recreational water, sexual practices, other types of person-to-person or animal contact, and travel. Of the 331 patients who submitted stool specimens, only four (1.2%) were positive for cryptosporidial antigen. Only one of the four was symptomatic at the time of interview. Of the 379 subjects who submitted a serum sample, 107 (28%) tested positive for anti-cryptosporidial immunoglobin G. Because of the low prevalence of stool positivity, the association between consumption of tap water and other risk factors studied, and enteric infection could not be assessed.. The City has not yet presented its findings on the relationships, if any, between risk factors and seropositivity.

<u>Conclusions/Recommendations</u> - EPA recommends that NYCDEP submit the final Giardiasis Study Report.

EPA recommends that NYCDEP finalize the Cryptosporidiosis Report and include an evaluation of the study results. These results will form the basis of additional studies that may be necessary in this area. In the meantime, EPA recommends that NYCDEP continue to

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[11] *Waterborne Disease Risk Assessment Program 1997 Annual Report* (NYCDEP 1998)

[12] Evelyn O. Talbott, Gunther F. Craun, Eds., *Introduction to Environmental Epidemiology* (Lewis Publishers 1995) p. 50.

develop research goals consistent with the objectives of the Disease Surveillance Program.

iv. Information Sharing and Public Education

The City's outreach and education efforts to date have been impressive. Over the last several years, NYCDEP and NYCDOH staff have made presentations to physicians and other health care providers on (among other issues) the need to request specific laboratory testing for cryptosporidiosis when the disease is suspected. They also issue periodic announcements to area hospitals and health care providers to persons with HIV/AIDS with information on *Cryptosporidium* and drinking water. NYCDEP maintains a website (http://www.ci.nyc.ny.us/dep/html/watersup.html) with health and waterborne disease information, links to NYCDOH fact sheets on giardiasis and cryptosporidiosis, and New York City Annual Drinking Water Supply and Quality Statements. Additionally, NYCDEP staff have participated in several work groups and peer review groups such as the National Drinking Water Advisory Council's Working Group on Health Care Provider Outreach and Education. NYCDEP staff have also contributed to the CDC's *Cryptosporidium and Water: A Public Health Handbook.*

Conclusions/Recommendations - EPA recommends that the City develop and disseminate a comprehensive public notification protocol on how it will address spikes in disease surveillance/outbreak detection data and well as the detection of pathogens entering the water supply system. This is an important step in instituting a system of control measures aimed at preventing or containing an outbreak of waterborne gastrointestinal illness. **EPA recommends that the City release and distribute health-related water supply information to as wide a group as practicable, including facilities or residential communities with a known population of elderly people or other individuals susceptible to waterborne pathogenic disease. EPA also recommends that NYCDEP reach out to all New York City-area hospitals and treatment facilities, including hospitals outside the City which treat City residents, to announce water supply/public health information.**

EPA recognizes that work in cryptosporidiosis detection methods, surveillance monitoring, and disease outbreak detection and control is evolving at a rapid pace. EPA also recognizes that NYCDEP maintains a well-qualified professional staff to participate in the development and assimilation of new information about cryptosporidiosis and other potentially waterborne diseases. **EPA recommends that information sharing and public education efforts continue. EPA recommends that the City continue to participate in technical workgroups and conferences.**

During the mid-course FAD review, those who provided comments on this Program were primarily interested in learning more about the relative risks from drinking New York City tap water compared to other risks taken in everyday life (e.g., risk of drinking tap water compared with the risk of driving a car). **EPA recommends that NYCDEP continue to look for more avenues to provide data and summary information about the incidence of waterborne disease producing pathogens to the**

public.

v. Risk Assessment

Risk assessment is the "systematic scientific characterization of potential adverse health effects resulting from human exposures to hazardous agents or situations. This type of assessment includes qualitative information on the strength of the evidence and the nature of the outcomes, quantitative assessment of the exposure and the potential magnitude of the risks, and a description of the uncertainties in the conclusions and estimates."[13] The 1999 NRC Report contained a risk assessment of the likelihood of contracting cryptosporidiosis from the New York City drinking water. The NRC Report recommended that:

- a *Cryptosporidium* risk assessment be performed on a periodic basis for New York City to help determine the contribution of watershed management to overall risk reduction, and that

- an ongoing program of risk assessment be used to complement active disease surveillance.

Conclusions/Recommendations - Risk assessment and risk management are tools to help enhance water consumers' understanding of the relationship between the City's water supply protection program and human health. On a national level, EPA is working on a risk assessment methodology for use with cryptosporidiosis. **As more information on appropriate risk assessment/risk management methods becomes available, EPA recommends that NYCDEP develop a methodology appropriate for its drinking water supply to calculate risk under various scenarios. EPA also recommends that risk assessment information be disseminated to the public to educate water consumers.**

[13] Casarett & Doull, Curtis D. Klaassen, Ed., *Toxicology: The Basic Science of Poisons* (McGraw Hill 1996) 5th Edition

III. Land Acquisition and Stewardship Program

1. Introduction - Program Description and Objectives

Land acquisition is one of the most effective, and therefore, important mechanisms to permanently protect the City's Catskill/Delaware watershed. The overarching goal of the Program is to ensure that undeveloped, environmentally-sensitive watershed lands remain protected and that the watershed continues to be a source of high-quality drinking water to the City and upstate counties. Its success is absolutely critical to EPA's continuance of filtration avoidance for the Catskill/Delaware system. The Land Acquisition Program has several programmatic objectives: (1) achieve FAD solicitation goals, (2) acquire a substantial amount of land, (3) maintain high water quality, and (4) promote water quality goals through strong stewardship. Although the FAD itself only contains solicitation goals, it is clearly EPA's intent that all of the above objectives be met.

Many of the terms used in the FAD such as "priority area," "eligible land" and "natural features criteria," as well as certain solicitation restrictions, are described in detail in the New York City Watershed Memorandum of Agreement (MOA) and are summarized here for informational purposes. Land solicitation is generally prioritized based on travel time to the City's distribution system (1A, 1B, 2, 3, and 4; 1A being the highest priority). In addition, to be eligible for acquisition, land must satisfy the natural features criteria, except in the Kensico and West Branch/Boyd's Corner basins, where the City may solicit and acquire *any* parcel (with a limit in commercial zones). How these criteria are applied to each Priority Area is presented in
Table III.1.

Approximately 1,049,000 acres of land lie in the Catskill/Delaware watershed (including West Branch and Kensico basins). Of that amount, the City owns 62,300 acres or 6% (pre-MOA and pre-FAD). The State owns approximately 200,000 acres or 20%, most of which is part of the Catskill Forest Preserve. Of the remaining 786,700 acres, approximately 550,000 meet the Natural Features Criteria and are therefore available for solicitation and acquisition. In accordance with the FAD, the City must solicit 355,050 acres, approximately two-thirds of eligible land, in the Catskill/Delaware watershed by seeking to acquire parcels in fee or conservation easement. FAD solicitation requirements, by year, are highlighted in Table III.2. The higher the priority land area, the higher the percentage of eligible land that the City must solicit (see Table III.3).

Table III.1 - Land Acquisition Eligibility Criteria[1]

Priority Area[2]	Natural Features Criteria	
	minimum acreage[3]	other restrictions
1A	1	none
1B	5	none
2	10	To be eligible for solicitation, a parcel must: (1) be at least partially located within 1,000 feet of a reservoir, a 100 year flood plain, or 300 feet of a watercourse as defined in the Watershed regulations, or (2) contain in whole or part a federal jurisdiction wetland greater than 5 acres or a NYSDEC mapped wetland, or (3) contain ground slopes greater than 15%
3	10	
4	10	

[1] Additional restrictions to the Land Acquisition Program can be found in the MOA at Article II.

[2] Priority areas defined:

1A - sub-basins within 60 day travel time to distribution system near intakes
1B - sub-basins within 60 day travel time to distribution system not near intakes
2 - sub-basins within terminal basins not within priority areas 1A and 1B
3 - sub-basins with identified water quality problems not in priority areas 1A, 1B, and 2
4 - all remaining sub-basins in non-terminal basins

[3] There is no minimum acreage restriction for Kensico and West Branch/Boyd's Corner drainage basins (priority 1A and 1B)

Table III.2 - FAD Solicitation Requirements

Deadline	**FAD Task**	**Acreage Requirement**	**Breakdown by Priority Area**	**Breakdown by Basin**
Jan. 21, 1998 (year 1)	301n	56,609	1 - 37,264 2 - 19,345	
Jan. 21, 1999 (year 2)	301o 301u	51,266	1 - 24,486 2 - 22,955 4 - 3,825	Kensico 950 West Branch 14,250 Ashokan 45,530 Rondout 28,975
		Running Total 107,875		

Deadline	FAD Task	Acreage Requirement	Breakdown by Priority Area	Breakdown by Basin
Jan. 21, 2000 (year 3)	301p 301v	42,733	3 - 14,198 4 - 28,535	Neversink - 12,988
		Running Total 150,608		
.Jan. 21, 2001 (year 4)	301q	52,846	3 - 24,769 4 - 28,077	
		Running Total 203,454		
Jan. 21, 2002 (year 5)	301r	55,265	3 - 22,395 4 - 32,870	
		Running Total 258,719		
Jan. 21, 2003 (year 6)	301s	48,531	3 - 20,081 4 - 28,450	
		Running Total 307,250		
Jan. 21, 2004 (year 7)				
		Running Total 307,250		
Jan. 21, 2005 (year 8)	301t 301w	47,800	3 - 14,557 4 - 33,243	Schoharie 68,700 Pepacton 78,630 Cannonsville 105,028
		Running Total 355,050		

Table III.3 - Solicitation Requirement by Priority Area

Priority Area	Estimated Eligible Acres in Priority Area	Solicitation Requirement	Solicitation Requirement as a Percentage of Eligible Acreage
1A & 1B	65,000	61,750	95%
2	47,000	42,300	90%

3	128,000	96,000	75%
4	310,000	155,000	50%
Total	**550,000**	**355,050**	**65%**

Also in accordance with the FAD, by December 16, 1996 the City was to have established a "land acquisition account" with an initial balance of $88 million. By December 2000, the City is to establish an aggregate total of $250 million in the account. The City may spend up to $10 million of the funds budgeted for land acquisition to acquire agricultural easements on working farms which have Whole Farm Plans in place. These acquisitions, however, will not count in the total acreage solicited for the Land Acquisition Program.

2. Background

On June 29,1989, EPA issued the Surface Water Treatment Rule (SWTR), promulgated pursuant to the Safe Drinking Water Act (SDWA), which specifies that a public water system using surface water must use filtration unless it meets certain source water quality and site-specific criteria. Of particular note is the requirement for a watershed control program (§141.71(b)(2)). Specifically, the SWTR states that a water supplier "must maintain a watershed control program which minimizes the potential for contamination by *Giardia lamblia* cysts and viruses in the source water." [The December 1998 Interim Enhanced Surface Water Treatment Rule included *Cryptosporidium* as part of the watershed control program.] Within the context of this program, the public water supply system must "demonstrate through ownership and/or written agreements with landowners within the watershed that it can control all human activities which may have an adverse impact on the microbiological quality of the source water." The adequacy of the program will be based on, among other things, "the extent to which the water system has maximized land ownership and/or controlled land use within the watershed." Cognizant of this mandate, the City's first filtration avoidance application laid out a framework of what would later become its land acquisition program.

The City's November 1991 filtration avoidance application to New York State Department of Health (NYSDOH) included a plan "to spend up to $47 million next year on land acquisition"[14] - with a goal of 10,000 acres. This effort, including the development of a long-term land acquisition plan, was memorialized in EPA's January 19, 1993 conditional Filtration Avoidance Determination as conditions 13a, b, and c. Unfortunately, within six months it became clear that the short-term land acquisition goal would not be met. Progress was initially hampered by delays within NYCDEP in establishing an organizational infrastructure that could effectively move the Land Acquisition Program forward (see

[14] New York City's Long-Range Water Quality, Watershed Protection and Filtration Avoidance Program (NYCDEP, November 1991)

Deliverable 301a, April 1994). In June 1993, the City submitted a Long-term Plan (Deliverable 13c) that committed it to a seven-year program for acquisition of an additional 70,000 acres and up to $220 million in funding. The City also increased its land acquisition program staff to 20 (Deliverable 13b, 6/93).

EPA's second FAD (December 30, 1993) required the City to assess the land acquisition program and to revise its long-term land acquisition plan. In addition, it required that the City commit $201 million to acquiring or otherwise restricting use on a minimum of 80,000 acres of land in the Catskill/Delaware watershed. By the time of the City's April 1994 assessment, no land had been acquired and a number of purchase options had expired. The primary stumbling blocks included the unanticipated complexity in negotiating land purchases and the inability to obtain a Water Supply Permit from New York State (pursuant to Article 15 of New York Environmental Conservation Law). The Water Supply Permit[15] is essentially a state permit that would allow New York City to buy land in the watershed, outside its municipal border. NYCDEP initially applied for the permit in August 1993. This application became the subject of a New York State Department of Environmental Conservation (NYSDEC) administrative proceeding. A number of upstate communities pressed to have the permit denied and threatened to sue if the permit were issued, further delaying any progress of the land acquisition program. Through 1994, the City had signed over 50 options, worth over $16 million, to buy from willing land owners. By early 1995, over $12 million of the $16 million-purchase options had expired. The signing of additional purchase options slowed considerably because land owners were hesitant to enter into option agreements with NYCDEP without the security of the Water Supply Permit in place.

It became clear that the land acquisition milestones of EPA's second conditional FAD would not be met and that the City was in serious jeopardy of losing its filtration avoidance status for its Catskill/Delaware system. In mid-1995, under the auspices of the New York State Governor's office, the City, State, upstate communities, EPA and environmental parties began negotiating what became the New York City Watershed MOA. The MOA was signed in January 1997 and laid out in detail the City's land acquisition and stewardship program. The MOA also facilitated the State's immediate issuance of a Water Supply Permit to the City and the removal of a number of legal challenges. EPA's May 1997 5-year FAD further memorialized the City's land acquisition program.

3. Assessment

A. Implementation Status - As stated at the beginning of this section, there are several programmatic objectives to the City's Land Acquisition Program: (1) achieve FAD solicitation goals, (2) acquire a substantial amount of land, (3) maintain high water quality, and (4) promote water quality goals through strong stewardship. The City's progress in meeting these objectives will be discussed

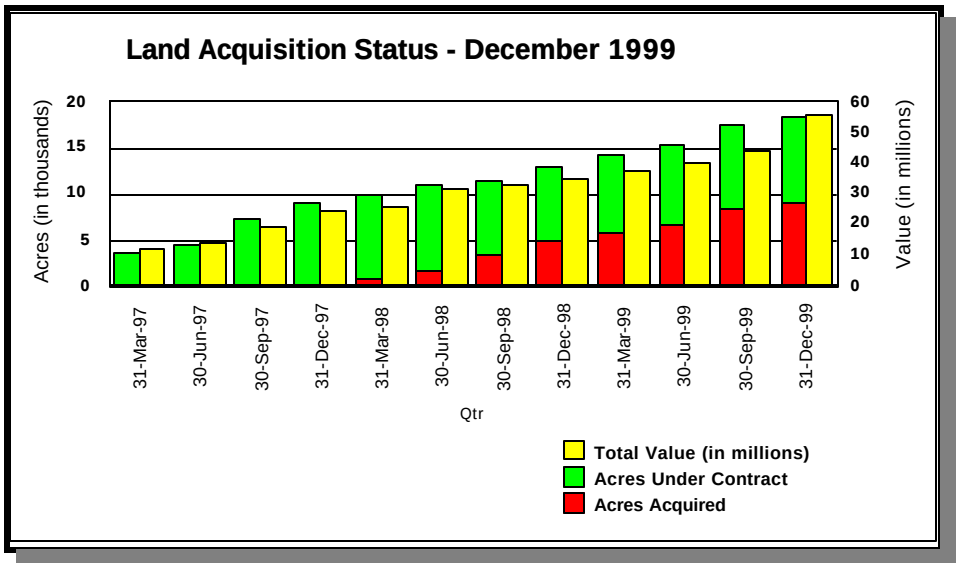
[15] City of New York's Water Supply Permit, DEC Permit No. 0-9999-00051/00001 issued January 21, 1997

below.

i. Compliance with FAD Solicitation Deadlines - In accordance with FAD task 301g, by December 16, 1996, the City submitted a permit application to NYSDEC to conduct the 10-year land acquisition program (approved by NYSDEC on January 21, 1997). In accordance with FAD task 301h, by December 16, 1996, the City established a separate land acquisition account and funded it initially with a balance of $88 million. By the end of Year 3 (January 21, 2000), NYCDEP had met all FAD solicitation requirements in the Land Acquisition Program (301L, 301m, 301n, 301o, 301p, 301u and 301v) and had solicited owners of 150,608 acres of land in the watershed. Specifically, the City met FAD requirement 301p by soliciting "individual landowners of 14,198 acres in Priority Area 3, and an additional 28,535 acres in Priority Area 4 for a total of 42,733 acres in the third year." The City met the FAD solicitation requirement 301v for the Neversink Basin." (See Table III.2 for the breakdown.) EPA notes that because there were only 161 acres of land available for solicitation in Neversink Priority Area 1 (not 238 as originally estimated), the total solicitation acreage was 12,911 acres, not 12,988 as stated in the FAD. The 77 acre shortfall was added to Rondout Priority Area 1.

In addition, in April 1998, in accordance with FAD Task 301j, NYCDEP, with EPA and NYSDOH, determined that the amount of money in the land acquisition account was sufficient for the upcoming 2-year period. In accordance with the MOA, after January 2002, "the City, EPA and NYSDOH will confer on the sufficiency of the $250,000,000 in light of the Land Acquisition Program's progress. If [EPA] determines it is necessary, the City will at that time commit up to an additional $50,000,000 for the [Catskill/Delaware] Land Acquisition Program." In making this determination, EPA will evaluate land acquisition and expenditures to date and the amount of active solicitations (i.e., landowners still showing interest in selling land).

Figure III.1



ii. Land Acquisition - Although not an explicit task or requirement of EPA's filtration avoidance determination, it is clearly a measure of the Land Acquisition Program's success that the City acquire a substantial amount of watershed land. EPA strongly believes that this is one of the most effective ways to protect an unfiltered drinking water source. In order to evaluate progress in this area we have used several different measuring tools. The most basic yardstick is to measure the amount of land acquired and under contract over time. This provides a general overview of the status of the Land Acquisition Program. As seen in Figure III.1, at the time the FAD was issued and the MOA was signed, the City was able to capitalize quickly on a number of parcels which were already under option. Actual acquisitions began in the last quarter of 1997. Since that time there has been fairly steady progress in land acquisition and land purchase contracts through December 1999. Another yardstick is to compare the acreage of land acquired (and under purchase contract) to the acreage of land solicited. This comparison is further refined as we look at acquisition totals in each reservoir basin and in each priority area within that basin. The results are summarized below in Table III.4.

Table III.4 - Status of Land Acquisition by Reservoir Basin at the End of Year 3

Reservoir basin	Priority area	Total acres solicited	Solicitation requirement by end of program	Acres acquired or under contract	Acres acquired or under contract as a percentage of land solicited
Kensico	1	950	950	17	2%
West Branch	1	14,250	14,250	5,389	38%
Ashokan	1	3,230	3,230	339	11%
	2	42,300	42,300	4,757	11%
Rondout	1	29,052[1]	28,975	3,457	12%
Neversink	1	161[1]	238	0	0%
	4	12,750	12,750	573	5%
Pepacton	1	1,805	1,805	46	3%
	3	6,210	15,525	0	0%
	4	12,260	61,300	1,277	10%
Cannonsville	1	12,303	12,303	265	2%
	3	-	48,525	-	-
	4	-	44,200	108	-

Schoharie	3	7,988	31,950	1,638	21%
	4	7,350	36,750	574	8%
Total		**150,608**	**355,050**	**18,440**	**12%**

[1] Priority Area 1A in Neversink contains 161 acres rather than the 238 acres that were estimated in the MOA. (This shortfall [77 acres] was shifted to Rondout Basin 1B.)

What follows is a discussion and evaluation of acquisition by basin:

Kensico: The protection of Kensico Reservoir, the terminal reservoir of the Catskill/Delaware system, is of vital importance in ensuring the delivery of high-quality drinking water to Westchester County and New York City. As such, it receives special scrutiny under EPA's filtration avoidance determination. All land in the Kensico watershed is considered Priority Area 1 for land acquisition. Besides the reservoir itself, the Kensico watershed includes approximately 6,000 acres, 2,015 (or 34%) of which are currently owned by the City as buffer land. Of the remaining 3,985 acres, 1,000 fit the eligibility requirement described above and are available for solicitation. In accordance with the FAD, the City is required to solicit 95% of those acres (i.e., 950 acres). Although the City has met the FAD solicitation requirement (it did so by January, 1999), it had only executed purchase contracts on 17 acres by the end of 1999. This represents only 2% of the land that it has solicited. This number is discouraging since the City has been soliciting and negotiating land purchases in the basin for almost three years. The parcel that the City is acquiring, however, is very significant since it is an area where the potential for commercial development is very strong. The City should continue to negotiate aggressively with landowners in the Kensico Watershed. It has stated that it expects to make additional purchases there; EPA has similar expectations.

West Branch: The West Branch is another critical watershed (along with Boyd Corners) in the Catskill/Delaware system. As such, all land in the West Branch and Boyd Corners watersheds is considered Priority Area 1 for acquisition. (For the purposes of this discussion, Boyd Corners will be considered part of the West Branch watershed.) Excluding the reservoir area itself, the West Branch watershed includes approximately 25,400 acres. Prior to the acquisition program, the City owned 810 acres of buffer land. The State owns approximately 2,520 acres (most of which reside in Fahnestock State Park or between the two northern arms of the West Branch reservoir). Of the approximately 14,800 acres of land that meet the eligibility requirement for solicitation and acquisition, the City has solicited 95% or 14,250 acres, as specified in the FAD and MOA. Admirably, to date, the City has executed purchase contracts on 1851 acres and has closed on 3538 acres. This represents 38% of the land solicited in the watershed that the City has or is in the process of acquiring. Important considerations are the size and location of the tracts that the City is acquiring. In the West Branch watershed, the City has purchased parcels as large as 900 acres. The fact that several of the largest parcels are

located very close to the reservoir itself is very impressive. Not only does this mean that the immediate buffer zone around the reservoir is expanded, but these properties are of a scale at which there is an excellent chance to maintain the integrity of the existing ecosystems. Among other things, these ecosystems (which include high-value wetlands) can be instrumental in protecting the quality of the water entering the reservoir. The acquisitions along or near Horse Pound Brook are particularly impressive. A number of the areas being acquired are highly-developable properties.

A cursory review of Table III.4 shows that the percentage of land acquired or in contract in the West Branch watershed (38%) far exceeds that in the other basins. Some of this difference may be due to the large number of three-year purchase options executed by the City in 1995 and 1996 that the City closed on in 1998, prior to their expiration. In other words, the City was able to "jump start" the acquisition process in the West Branch watershed because it had worked to meet earlier FAD (pre-1997) commitments. NYCDEP had become a "presence" in the West Branch watershed area at a relatively early date, lending the program a baseline credibility. In other basins, the City has had to start from scratch. In summary, the ongoing acquisition program in this area is clearly a success story and we encourage the City to continue its efforts. In particular, we suggest the City focus on areas where large-scale development is most likely.

Ashokan: In accordance with the FAD, by January 21, 1999, the City had solicited all required land (45,530 acres) in the Ashokan basin. 3,230 of these acres are in Priority Area 1 and 42,300 are in Priority Area 2. As shown in Table III.4, the City has acquired or has under contract approximately 11% of the land it solicited in both priority areas. We note that the first acquisition in the Land Acquisition Program occurred in the Ashokan basin in September 1997. The City has made good progress in the Ashokan basin compared to its results to date in most other basin areas, with the exception of West Branch. As in West Branch, the City was able to "jump-start" the program here by capitalizing on approximately 20 three-year purchase options that had been executed in 1995 and 1996. Since that time, the City seems to have had better success in West Branch from an acreage standpoint, although it has acquired more parcels in Ashokan. The City was able to purchase some critical parcels in Ashokan such as the two adjacent to existing buffer land, one which had already been subdivided for development (122 acres) and the other which includes a significant amount of high-value wetlands (80 acres). The City has also been able to purchase a number of large parcels (100+ acres) in Woodstock.

Consistent with the City's Stream Corridor Protection Strategy[16] and its Turbidity Reduction

[16] *Strategy for Stream Corridor Protection Program* (NYCDEP, June 1994)

Strategy[17], NYCDEP should focus acquisition resources in areas with known water quality or stream stability concerns, such as Woodland, Stony Clove and Esopus Creeks. To date there has been minimal acquisition along these watercourses.

Rondout: As with the preceding basins (West Branch, Kensico, and Ashokan), the City has completed the solicitation phase of the Land Acquisition Program. By January 1999, the City had solicited 28,975 acres in Rondout basin, all of which lie in Priority Area 1. As of December 1999, the City had acquired or has under contract approximately 12% of the land that it has solicited. It has been particularly successful in Priority Area 1A (sub-basins near aqueduct intakes), where it has acquired approximately 50% of available acreage. There were no solicitations in Rondout basin prior to the 1997 FAD; thus all the progress in this basin has occurred in the last three years. Prior to the FAD, the City held very little buffer land around the Rondout Reservoir. We encourage the City to continue its efforts to acquire land in this basin.

Neversink: The Neversink watershed is the most pristine of the Catskill/Delaware basins. The goal of the land acquisition program is to keep it that way. In accordance with the FAD and the MOA, solicitation did not begin in this watershed until January 1998. By the end of 1999, solicitation of all required acreage (238 acres in Priority Area 1 and 12,750 acres in Priority Area 4) had been completed. The City has not acquired any property in Priority Area 1. It has acquired or is under contract to acquire 573 acres in Priority Area 4. The City is fortunate in that it already owns a significant amount of buffer land immediately adjacent to the Neversink Reservoir. Through the Land Acquisition Program, EPA expects the City to expand this buffer around the reservoir and along watercourses in the near future.

Pepacton: In accordance with the FAD and the MOA, the City has only partially completed its long-term solicitation requirements in the Pepacton watershed. It has, however, completed soliciting land in Priority Area 1. It is difficult to gauge the Program's progress because it only recently began in this basin. Looking forward, the City has a significant amount of discretion in choosing land to solicit since much of it is in Priority Area 3 and 4. Targeted use of resources will be very important in the Pepacton basin. (See further discussion on this in the section on Maintenance of Water Quality, below.)

Cannonsville: The City has only recently begun to solicit land in the Cannonsville watershed. In accordance with the FAD and the MOA, it has solicited 12,303 acres (all in Priority Area 1). It is scheduled to solicit 92,725 acres in Years 4 through 8 of the program. It has had some success in Priority Area 1. We look forward to seeing progress in this basin as the

[17] *Short- and Long-term Plans to Reduce Turbidity in Schoharie and Ashokan Reservoirs*, FAD deliverable 14c (NYCDEP June 1993)

program accelerates. As with Pepacton, the City has a great deal of discretion to target high-value parcels in Cannonsville for solicitation.

Schoharie: In accordance with the FAD and the MOA, the City solicited 15,338 acres in the Schoharie watershed. Solicitation began in Year 3 of the program. In Year 4 through Year 8, the City is expected to solicit 53,362 acres. All acreage in the Schoharie basin is considered Priority Area 3 or 4. The City has acquired or has under contract approximately 19% of the Priority 3 land that it has solicited to date - an impressive accomplishment. Priority 3 land in the Schoharie basin is particularly important because it includes stream corridors, such as sections of Schoharie Creek and Batavia Kill, that are a source of high loads of suspended solids into the reservoir. The City should focus solicitation on areas that are prioritized for stream corridor stabilization and restoration. To date there has been very little acquisition along these two problematic watercourses.

iii. Maintenance of Water Quality - An overriding objective of the Land Acquisition Program is to maintain high water quality in the Catskill/Delaware System and to enhance the existing "margin of safety" to a system that currently provides the City and upstate counties with an excellent drinking water supply. EPA views land acquisition as the most efficient and direct watershed protection program available to meet this objective. Because the function of this program is primarily "protection" rather than "remediation," overall success will be gauged by the City's routine comprehensive monitoring program and continued compliance with existing regulations. For a more detailed discussion of the City's routine monitoring program and its use in monitoring protection programs, refer to Chapter XIII.

The remediation component to the Land Acquisition Program should not be overlooked. Land acquisition can be targeted to areas that need remediation (e.g., where there are existing water quality concerns) and in areas that are most susceptible to water quality degradation. For example, by purchasing (and thereby controlling) land that has been shown to be a source of water quality/streambank stability problems, NYCDEP can more easily and effectively institute mitigation techniques (e.g., riparian buffers). In fact, land acquisition is a key component of the City's Stream Corridor Protection Strategy (FAD deliverable 308c, 6/94) and can also help meet the goals of the Turbidity Reduction Strategy (FAD deliverable 308f, 6/93). (We note that monitoring and land-use models [e.g., GWLF] can and should be a significant aid in this effort.)

In addition, to achieve the objective of maintaining high water quality, it is very important that the City target land acquisition in water quality sensitive areas. Targeting water quality sensitive areas is particularly critical in Priority Area 4, which contains over half (310,000 acres) of the eligible land in the solicitation/acquisition program (550,000 acres). Since only 50% of those 310,000 acres are required to be solicited, the City can be very selective in the land it solicits in Priority Area 4. And because of the vast acreage, the quality of the land solicited and acquired could have a large effect on protecting long-term water quality.

The City has, to some degree, targeted land due to the existing prioritization scheme of the Land Acquisition Program. For example, Priority Area 3 is defined as sub-basins with existing water quality problems. Priority Area 3 is subject to a higher land solicitation percentage requirement (75% vs. 50% for Area 4). In addition, the natural features criteria ensures, at a gross level, that the land being solicited has water quality benefits. However, there is quite a bit of latitude within the program's existing framework to make important water quality based solicitation decisions.

EPA recommends that the City articulate a plan of how it intends to prioritize the solicitation of land in Priority Areas 3 and 4. This need was not paramount in the first two years of the program, when resources were expended on ensuring solicitation goals were met in Priority Areas 1 and 2; however, by the end of 1999, almost 47,000 acres were solicited in Priority Areas 3 and 4. In fact, all remaining solicitation requirements will be in Priority Areas 3 and 4. Thus, this prioritization scheme will drive the program forward. Central to this program should be increased focus on the acquisition of developable wetlands and landscape areas that are unstable and that are sources of high turbidity. Strong coordination and integration are vital among the Land Acquisition, Streambank Restoration, and Wetlands Protection Programs. We encourage the City to increase the use of its geographic information system (GIS) to facilitate the integration of these programs and to present its prioritization efforts.

iv. Promotion of Water quality Goals through Strong Stewardship - While not a specific FAD "deliverable," EPA believes that effective stewardship is an integral part of a successful Land Acquisition Program. A good stewardship program bridges land acquisition and achievement of water quality goals. It is an opportunity for the City to enhance awareness of environmental protection among those who use its watershed lands. As soon as the MOA and FAD were signed, there were high expectations, particularly from recreational advocates in the watershed communities, for newly acquired City-owned land to be opened quickly for recreational use. However, as acknowledged in its *Preliminary Report on Recreational Use of New York City Water Supply Lands* (January, 1999), the City must balance the expansion of access with its overarching mandate to protect its drinking water supply.

The City made significant strides in early 1998 when it hired a Program Manager dedicated to develop and implement its stewardship program. In January 1999, the City released its *Recreational Use* report, cited above, which provides a framework for the program. In a May 6, 1999 letter, EPA commented that the Report was "comprehensive" and that it provided a "process for 'opening up' City land for recreational use in a manner that focuses on watershed protection first and foremost." Since that time the City has opened up over a thousand acres for fishing and over a thousand acres for hiking. By allowing increased access to City-owned land in the watershed, the City has an opportunity to enhance its role among the watershed communities. We commend the City for taking a thoughtful approach to developing and implementing a long-term, effective stewardship program. However, some fear has been expressed during the public comment period that the access-by-permit program will be cumbersome and overly restrictive. EPA looks to the City to ensure that an appropriate balance is

maintained between increased community access to its watershed lands and the protection of its water supply.

Looking forward, our main concern is that adequate resources be devoted to ensuring that increased access does not lead to environmental degradation in high-use areas. This problem is already apparent in some pre-MOA/FAD, City-owned buffer areas. EPA recommends that the City complete its comprehensive land and resource management plans expeditiously.

B. ***Ancillary Programs*** - We note that there are a number of other watershed protection programs that supplement work being performed through the Land Acquisition Program. Closely tied to the Land Acquisition Program is the Floodplain Buyout Program, a cooperative effort between the City, Delaware County, and the Federal Emergency Management Agency (FEMA). In this program, owners of homes damaged in the 1996 floods will sell their property to the City at pre-flood values. The City and Delaware County entered into contracts to purchase a total of 29 homes, 21 of which are in Margaretville. All homes are being dismantled and the properties will be maintained in a natural state to enhance the capacity of the floodplain and protect water quality. Approximately 16 acres are involved in this program.

Other important programs include the Agricultural Easement Program and the Conservation Reserve Enhancement Program, both of which are discussed in more detail as part of our evaluation of the Watershed Agricultural Program and the Wetlands Protection Program (see Chapters IV and VI, respectively).

4. Conclusions/Recommendations

As of January 21, 2000, the three-year point in the Land Acquisition Program, the City has met all of its solicitation goals as outlined in the FAD and MOA. While it is not a specific FAD requirement, land acquisition is clearly the yardstick by which EPA will ultimately measure success. To date, the City has shown significant progress in acquiring land in a number of basins, particularly West Branch, where it has acquired or executed purchase contracts on 5,389 acres, or 38% of the land it has solicited. We see the excellent progress made in West Branch as one benchmark by which to gauge success of the Land Acquisition Program in all other basins. **EPA recommends that the City continue its efforts in West Branch and that it ramp-up its program in other west-of-Hudson basins.**

Unfortunately, progress to date is poor in Kensico, probably the most critical watershed in the Catskill/Delaware system, where, out of 1000 acres available for solicitation, only 17 acres (2% of the land that has been solicited) has been acquired or is under contract. This is a weak point in the Land Acquisition Program (and in the City's overall watershed protection efforts). NYCDEP has stated that it is actively negotiating with a number of landowners and that it expects to make additional purchases in the Kensico basin shortly. **EPA strongly recommends that the City re-double its efforts, using all means available, to acquire land or easements to protect the remaining open space in the Kensico watershed. To that end, EPA recommends that the City develop an intensive solicitation/acquisition strategy, specific to the Kensico watershed. If significant progress in acquiring land is not made in the near term, the City must work with local governments to ensure that they use their land use authorities to protect this vitally important Catskill/Delaware watershed.** In light of the lack of program progress thus far in Kensico, EPA has particular concerns regarding the use of Nationwide Permits for wetlands fill projects in the Kensico watershed. EPA has recommended to the New York District of the Army Corps of Engineers that use of Nationwide Permit 39 be prohibited from use in the watersheds east-of-Hudson. This would ensure that any development project that impacts wetlands is subject to a full review under the federal wetlands regulatory program.

In accordance with the FAD, the City has completed soliciting land in Priority Areas 1 and 2. **EPA recommends that the City continue its efforts to acquire critical watershed lands by periodically re-soliciting landowners in Priority Areas 1 and 2.** In the remaining years of the Land Acquisition Program, the City is scheduled to solicit land only in Priority Areas 3 and 4. With this shift, the City will be presented with much more flexibility in deciding which land to solicit. **EPA recommends that the City develop a plan that explains how it intends to prioritize the solicitation of land in Priority Areas 3 and 4. EPA recommends that the plan make full use of the City's water quality monitoring data and terrestrial models and that it include a direct link to the objectives of the Streambank Restoration and Wetlands Protection Programs. The City should maximize use of its GIS to facilitate these efforts.**

The City's Stewardship Program is beginning to show results and community acceptance as exemplified

by its recently opening up newly acquired land to fishing, hiking and hunting through its new permit program. However, there is significant evidence of erosion on pre-MOA, City-owned land where access is currently allowed (documented in NYCDEP's Preliminary Recreational Use Report [1999]). Access means additional stewardship responsibilities and educational opportunities. An expansion of its stewardship program warrants a significant expansion of resources to respond to increased use. **EPA recommends that the City complete its comprehensive land and resource management plans expeditiously and show how it will ensure that increased access does not lead to environmental degradation in high-use areas**. (Recent additions to the watershed police may be very useful in addressing this concern.) At the same time, increasing access to City-owned land is an opportunity for the City to bolster its standing within the watershed communities and to enhance a sense of stewardship among watershed residents. **EPA recommends that NYCDEP continue to work with communities to make the access program a success, and to ensure that an appropriate balance is maintained between increased access to its watershed lands and the protection of its water supply.**

It was EPA's expectation that the time between contract and closing (acquisition), which started off at 16-18 months, would be reduced considerably as the Land Acquisition Program matured. This has not been the case. **EPA recommends that the City work to streamline its internal acquisition process such that the time between contract and closing is reduced to 12 months or less.**

IV. Watershed Agricultural Program

1. Program Objectives

The overall objective of the Watershed Agricultural Program (WAP) is to prevent pollution and improve water quality by reducing pollutants leaving the farm through the implementation of management practices. The primary pollutants of concern are pathogens, phosphorus and sediment. The WAP is designed to meet these objectives through the development and implementation of Whole Farm Plans on at least 85% of the farms in the New York City watershed. A secondary objective of the WAP is to conduct scientific research in support of agricultural management practices utilized in the watershed. Although not a specific FAD requirement, this applied research plays an important role in the effective implementation of the program. Success of the WAP will be measured by the level of implementation and a reduction in the amount of contaminants leaving the farm. Reductions in contaminants leaving the farm will be determined through both monitoring and modeling programs. Over the long term, the WAP should result in improved water quality in the City's reservoirs.

The FAD contains several deliverables for the WAP. In 1997 the Watershed Agricultural Council (WAC) and NYCDEP proposed a modification to the FAD deliverables to emphasize the need for implementation and follow-up visits to the farm. This modification was approved by EPA in April 1998.

2. Background

In late 1990, New York City proposed revised Watershed Rules and Regulations. That proposal contained agricultural regulations that would have had a significant impact on the farming community. The Watershed Agricultural Program (WAP), which resulted from ensuing stakeholder discussions, recognizes that agriculture is a preferred land use in the watershed and that a voluntary program to prevent pollutants from impacting water quality could be more effectively implemented than regulations. Key aspects of the WAP are leadership through the local farming community (via the WAC), a commitment to support scientific research, multiple partnerships, the implementation of a multi-barrier approach to watershed protection and funding by New York City, supplemented by federal, State and local sources.

Phase I of WAP began in 1992 with the design and implementation of management practices on ten demonstration farms. The primary goal of this pilot effort was to develop a Whole Farm Planning and Implementation Procedure (WAC Evaluation Committee, December 1994). NYCDEP expended $4 million to implement Phase I, which included funding for scientific research to support management practices. Phase I was evaluated (as required by December 1993 FAD Task 306f) in December 1994. The Evaluation Committee found that basic expectations were met, significant progress was

made in developing a program guide, and plans were well received by the pilot farmers. However, improvement was needed with respect to meeting expectations of participating farmers and establishing a farm retention/incentive program. The committee also recommended that a prioritization procedure be established to reduce costs while still meeting water quality objectives. In addition, the Committee recommended that pathogens be the focus of scientific research and that the planning guide be refined. These issues were addressed during Phase II.

The WAP has grown throughout Phase II to include several additional programs which encourage water quality protection through maintaining well managed farms. These programs are Forestry, Whole Farm Easements and the Conservation Reserve Enhancement Program. Each of these programs will be considered in the assessment of the WAP, although they are not FAD milestones. The WAP has been subject to several evaluations which have provided valuable information for use in this review. The FAD requires that the WAP be evaluated every two years to determine the effectiveness of the program on an ongoing basis and to determine if changes are necessary. In December 1996, NYCDEP, in cooperation with the WAC, developed evaluation criteria that formed the basis of the biennial evaluations (FAD requirement 306q-1). The criteria range from an administrative accounting of farmer participation through qualitative and quantitative measures of program effectiveness. The WAP evaluation criteria follow.

- Farmer participation,
- Acceptance, implementation and maintenance of Whole Farm Plans by farmers,
- Estimated risk reduction in phosphorus and parasite loading to watercourses,
- Efficacy of whole farm planning and implementation process, and
- Science of whole farm planning.

The WAP evaluation identifies two scales to examine effectiveness of watershed management through agricultural practices - the whole farm scale and the reservoir scale. The whole farm scale evaluates changes in individual farm practices within the context of the entire farm. The reservoir scale evaluation is a broad-based, long-term assessment of water quality in a reservoir, which considers impacts from every pollutant source, including agriculture.

In addition to the biennial evaluation required by the FAD, two other evaluations have been conducted. In 1998, the WAC commissioned an independent review of the program (New York City Watershed Agricultural Program Review, 1998). The review panel consisted of professionals in program management, policy development, watershed management, water supply management, hydrology and agronomy. The purpose of this review was to develop observations and recommendations that could be used to strengthen and build upon the existing program. In 1999, the National Research Council completed its assessment of New York City's approach to watershed management. This assessment included a chapter on the WAP and included several recommendations to enhance the program. Individual comments and meetings with the several parties with an interest in the FAD, including meetings with the WAC, have also provided information used in the mid-course FAD review.

3. Assessment

To determine if the objectives of the WAP have been met, several criteria in addition to FAD requirements will be used. The independent 1998 WAC Evaluation noted that the program has been successful in the areas of providing technical expertise and building partnerships. The level of implementation, impacts on water quality, application of research results, adequacy of monitoring programs and initiatives to expand the program will be discussed in the following sections.

A. FAD Compliance

Through December 1999, each of the key milestones required by the FAD has been met by the WAP as shown in Table IV.1.

Table IV.1 - Compliance with FAD Milestones

FAD Condition	Goal	Achievement (12/99)
Farms Signed Up (306n-2)	297	310
Whole Farm Plans Approved (306p-3)	225	229
Whole Farm Plans Commenced Implementation (306p-8)	136	167
Whole Farm Plans Complete (306p-15)	47	50
Annual Follow-ups (306p-23)	30	179

The FAD also contains requirements for biennial evaluations (306q) and the drafting of agricultural regulations (306i-1). NYCDEP would be required to draft regulations for agricultural activities within 9 months of the following actions: (1) EPA determines that NYCDEP has failed to meet the requirements of the Watershed Agricultural Program, or (2) EPA determines that, based on a review of the biennial evaluations, the current Watershed Agricultural Program activities do not adequately control agricultural non-point source pollution. Since the Program is meeting all requirements, NYCDEP has not been required to draft regulations.

B. Implementation

The initial goals of Phase II were to have 85% of farms in the watershed participating in the program by October 1997 and to have all Whole Farm Plans completed by October 1998. These goals focused

on program participation and development of Whole Farm Plans. Forty-two US Department of Agriculture (USDA) - Natural Resource Conservation Service (NRCS) management practices are utilized in the WAP to address a variety of pollutant sources (see Table IV.2 for a status on implementation of these "best management practices" [BMPs] to date). Management options to be considered for each pollutant source category are listed in the Watershed Decision Support Manual utilized in plan development.

Table IV.2 - Status of BMP Implementation through 1999[1]

Watershed Agricultural Program BMP Implementation 1992-1999 (Includes Phase I and II Implementation)			
BMP Name	**# of BMPs**	**BMP Name**	**# of BMPs**
Waste Transfer System	5	Heavy Use Area Protection	32
Waste Field Storage	3	Spring Development	43
Waste Storage Structure	17	Animal Trails & Walkways	20
Brush Management	4	Streambank Protection	9
Conservation Crop Rotation	85	Stream Channel Stabilization	1
Conservation Tillage	2	Contour Stripcropping	4
Cover & Green Manure Crop	6	Field Stripcropping	18
Critical Area Planting	6	Structure for Water Control	6
Diversion	52	Nutrient Management	115
Fencing	73	Pesticide Management	8
Milkhouse Waste System	28	Subsurface Drain	77
Filter Strip	6	Tree/Shrub Establishment	1
Forest Land Erosion Control	1	Trough or Tank	14
Grasses & Legumes in Rotation	7	Underground Outlet	8
Grassed Waterway	7	Waste Utilization	27
Lined Waterway	14	Waste Transfer	3
Use Exclusion	2	Barnyard Water Mgmt. System	75
Obstruction Removal	5	Manure Pile Areas	4
Pasture & Hayland Planting	8	BMPs without NRCS Specs. (e.g. pathogen & herd health mgt.)	211

Forage Harvest Management	2	Access Road	39
Pasture & Hayland Management	32	Barnyard Runoff Mgmt. System	10
Pipeline	4	Prescribed Grazing	32
Total No. of BMP Practices	**1126**		
Total Cost	**$8,298,725**		

[1] *Watershed Agricultural Program Evaluation* (NYCDEP, 2000)

In addition to farmer participation and plan development, continued acceptance and implementation of plans by participating farmers is important. To gauge the level of acceptance, the WAP 1997 evaluation included a survey of farmers' attitudes. Overall, the responses were positive. Farmers believed that the practices selected for their farms were appropriate. They were satisfied with the level of support received, and their knowledge of potential negative impacts on water quality from farm related contaminants had increased. Approximately 50% of farmers had changed manure spreading practices. Most negative comments related to the waiting period between plan approval and implementation. The evaluation also included interviews with 10% of the farmers, conducted by WAP staff. They responded positively, with the exception that most found implementation to be too slow. Follow-up visits for providing the latest technical information and plan modification were also recommended. The WAC 1998 independent review also noted that the program required a significant level of follow-up with the farmer and improved implementation in order for it to have continued success.

Through these reviews, the WAC recognized that, as program participation increased, additional emphasis was needed on implementing plans and providing technical assistance to farms with plans already approved. As a result, NYCDEP requested and received a FAD modification in 1998 which reflected the need to increase implementation and follow-up. (These changes are reflected in Table IV.1.) It is anticipated that many of the concerns expressed by farmers will be addressed through this modification.

In 1997, implementation was not addressed through FAD deliverables. However, WAC had set an internal goal of beginning implementation on 20% of Whole Farm Plans approved. By July 1997, implementation had begun on 58% of the plans. Out of 1,333 management practices approved at that time, 307 were implemented. In 1998, 375 additional management practices were implemented at a cost of $2,642,046. In 1999, 266 management practices were implemented with at a total cost of $2,240,000, and implementation had begun on 73% of approved Whole Farm Plans. A similar level of implementation is expected in the year 2000.

The WAP has been successfully implemented from its initiation. As the program continues to move from planning to implementation, the Watershed Agricultural Council often discusses issues regarding the most effective way to implement the program, as well as its initiatives. Many of these discussions

have resulted in improvements. As implementation issues continue to surface, EPA expects that the WAP will continue to evolve.

C. Water Quality

The WAP takes a multi-barrier approach to protecting water quality. The management practices recommended through the program aim to reduce or eliminate pollutants at the source, control the transport of pollutants across the landscape and protect the stream corridor.

To evaluate the effectiveness of the WAP in maintaining or enhancing water quality, the reduction of pollutant loads by the implementation of Whole Farm Plans must be determined. Direct water quality monitoring as well as water quality models are tools to aid in this determination. However, there are severe technical limitations to using direct measurements to demonstrate the effectiveness of management practices to control non-point sources of pollution (e.g., sample collection, temporal variability, analytical methods for pathogens). Despite these limitations, data from the farm, field and watershed scales are necessary to test and validate models if they are expected to adequately estimate the overall impact of the WAP on water quality.

Although not documented by direct monitoring results, through indirect measurements it can be concluded that the WAP has a positive impact on water quality. Source reduction of pathogens through improved herd health decreases the potential number of pathogens available for transport to a waterbody. Redirecting clean runoff away from areas with high concentrations of contaminants decreases the pollutant load which reaches the waterbody. Identification of hydrologically sensitive areas and the avoidance of manure spreading in these areas also decreases the runoff of pollutants. The management practices used along stream corridors are known to slow surface runoff, trap sediment and its associated contaminants, and increase water infiltration.

i. Monitoring

NYSDEC is conducting a paired watershed study at a single farm and an un-farmed site to determine the degree of water quality improvement after the implementation of management practices. The results will demonstrate the program's ability to identify sources and reduce pollutants. Data at both sites were collected for two years prior to BMP implementation on the farm. Data for the first year of post-implementation monitoring have been compiled into a preliminary report available at www.empireone.net/~mrraffer/wb/index.html.[18] Data from only one year of post-implementation is insufficient to draw conclusions on the effectiveness of Whole Farm Planing. However, some changes

[18] Longabucco, P., M. Rafferty, J. Lojpersberger, *Effectiveness of Whole Farm Planning and Implementation in Achieving Water Quality Improvements and Protection of New York City Water Supplies - Preliminary Analysis of the First Year of Sampling Data Following BMP Implementation at the Roberston Farm. .* (NYSDEC, 1999)

were observed. Losses of total dissolved phosphorus, soluble reactive phosphorus and total ammonia from the farm appear to have been reduced. The benthic community in the farm stream has shown improvement, indicating increased biological health of the stream. However, particulate phosphorus and total suspended solids had not shown a decrease, possibly due to the recent installation of some practices and residual disturbed areas. Additionally, overall nutrients and sediments were still above levels at the control site. As previously mentioned, the impacts of management practices are difficult to monitor and may take several years to be observed in the stream. Additional monitoring to evaluate reductions on the farm scale, such as this paired watershed study, would be useful.

Additional monitoring of the effectiveness of the WAP and the specific management practices utilized needs to be conducted. This has been recognized by WAC, NYCDEP and the NRC 1999 Assessment. To substantially address this concern, NYCDEP and WAC have secured non-city funds in addition to City-funded scientific support staff to conduct monitoring in the Town Brook sub-basin. Proposed tasks are as follows:

- Evaluate BMPs that have potential to reduce phosphorus loss in runoff
- Evaluate the potential benefits of stream bank fencing and riparian buffers,
- Evaluate effectiveness of barnyard installation and filter strips to treat barnyard runoff, and
- Quantify potential subsurface transport of phosphorus below cropped and pasture land.

In addition, Delaware County, in support of its Phosphorus Reduction Strategy, has obtained funds to conduct a study on the reduction of agricultural phosphorus through intensive forage management. Also, NYCDEP conducts extensive routine monitoring in the Cannonsville Reservoir basin (see Chapter XIII). Long-term changes in water quality, which may be partly attributed to the WAP, are expected to be observed through the existing monitoring program. Monitoring conducted through the WAP will assist NYCDEP in developing data needed to refine its Generalized Watershed Loading Function model (GWLF) for use in Phase III Total Maximum Daily Loads. An assessment of the GWLF modeling effort is in Chapter X of this report.

ii. Modeling

Water quality models are evaluation tools that can contribute to the assessment the WAP, aid in the estimation of load reduction and provide important feedback to the WAP in its effort to improve farm management practices. For the 1997 WAP evaluation, NYCDEP developed conceptual models to evaluate the risk from nutrients and parasites in runoff. The evaluation tools used for phosphorus included the following:

- Cornell Soil Moisture Routing Model
- Universal Soil Loss Equation

- Hydrologically Sensitive Area (HSA) Model
- Manure Application Simulation Model
- Soluble Phosphorus Field Export Model

For *Cryptosporidium*, the 1997 WAP evaluation presented a modeling structure that could be used for a quantitative evaluation once more information is available on oocyst loading and transport.

These models were applied to a single farm. Results of this effort indicate that Whole Farm Plans should reduce the risk of contamination from nutrients and parasites. They are summarized as follows:

- Structural changes to the barn area can reduce runoff across contaminated surfaces by 50%.
- Phosphorus loads from barnyard areas with manure can be expected to be reduced by 33%.
- A slight decline in phosphorus loading from fields can be expected.
- The HSA Model can be used to apply manure to minimize the potential for contaminants in runoff.
- Changes in the cropping pattern on the test farm are expected to reduce soil loss by approximately 275 tons per year.

Additionally, these models provide input to management practices, particularly in the area of nutrient management. Further detail on the models can be found in the 1997 WAP Evaluation.

As mentioned above, NYCDEP has also developed the GWLF model for use in the Cannonsville basin. In the long-term, this model will be useful in estimating the level of reductions from agriculturally derived phosphorus (as well as other sources) needed for the Cannonsville basin to achieve water quality standards, and for projecting the WAP's ability to achieve those reductions.

D. Research

The WAP has supported several research projects conducted by Cornell University to scientifically validate the whole farm planning process. The independent 1998 WAC Evaluation recognized that the program has been successful in promoting scientific research. Results of these research efforts have been utilized in developing the Environmental Review/Problem Diagnosis document, which is used to assess potential contamination sources on the farm. Results have also been used in selecting management practices and guiding the program to focus on calves as the primary source of *Cryptosporidium* on the farm. Although this research has been useful to date, continued research would certainly benefit the program. The projects are briefly described below (Cornell University

Phase II Twelfth Quarter Completion Report, 1997).[19]

Specific Development of Computerized Tools to Integrate and Apply Knowledge for Developing Nutrient Management Plans on Dairy Farms

The Cornell Nutrient Management Planning System (CNMPS) consists of tools for mass nutrient balance, crop nutrient management, animal nutrient management and crop rotation. Computerized forms were developed for mass nutrient balance and crop nutrient management. Animal nutrient management utilizes an improved version of the Cornell Net Carbohydrate and Protein System. The crop rotation component links the animal and crop nutrient management components. Also under this effort, the USDA NRCS Phosphorus Index is being adapted for the watershed.

Pasture Assessment and Grassland Management

Data were collected to fill informational gaps to quantify environmental effects and nutrient flow from well managed pasture-based systems. Research was conducted in the areas of pasture quantity and quality, dry matter intake and nutrient flows and distribution.

Risk Assessment Framework and Risk Reduction in Whole Farm Planning

Research focused on *Giardia* and *Cryptosporidium* on dairy farms. Specific areas of study were prevalence and incidence of infection in dairy herds and analysis of management practices influencing infection.

Pathogen Viability Research Support

Laboratory and field experiments were conducted to establish *Cryptosporidium* survival and transport characteristics. Results include a method to purify oocysts for use in experiments, a method to extract oocysts from soil, a viability assay methodology, and information on the effects of ammonia, passive composting and surface soil conditions on viability.

Hydrologic Basis for Whole Farm Planning Risk Assessment and Management

Research was conducted to strengthen the understanding of Catskill hydrology and to

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[19] *Cornell University Phase II Twelfth Quarter Completion Report.* Science for Whole Farm Planning. New York State Water Resources Institute. Cornell University Center for the Environment. (1997)

develop tools for effective farm assessments. Areas of research included runoff risk assessments from hillslopes, frozen soils, low permeability soils and floodplains and contaminant transport.

Quantifying Contributions of Agriculturally Derived Nutrients to Water Quality

Simulation models and field measurements were used to evaluate the role of soils as sources and sinks of nutrients. The Leaching Estimation and Chemistry model was modified and expanded to include phosphorus and a visualization tool.

E. WAP Initiatives

The WAP has continued to advance the program goal of maintaining agriculture as a preferred land use by initiating several programs not required by the FAD. These programs provide additional opportunities for pollution prevention, provide incentives for farmer participation and demonstrate a strong commitment by NYCDEP and WAC to conduct a successful program. New York City is commended for supporting these initiatives which are well beyond the requirements of the FAD.

Conservation Reserve Enhancement Program

NYCDEP has entered into a Memorandum of Agreement with the USDA and New York State to implement a Conservation Reserve Enhancement Program (CREP) in the watershed. The program allows farmers to retire environmentally sensitive land from production for 10 to 15 years. The USDA pays the farmer approximately $90 per acre per year and contributes 50% of the cost of establishing riparian buffers and/or permanent vegetative cover. Through the WAP, the City will pay the remaining 50% of the cost. The goal for the CREP is to enroll 5,000 acres in five years and to establish at least 165 miles of riparian buffers. The program is being well received, with over 75 farmers expressing an interest. As of January 2000, 23 CREP projects have been approved by WAC and eight contracts have been completed. Existing WAC approved projects cover approximately 190 acres of land.

Watershed Forestry Program

The Watershed Forestry Program was developed as a result of the Watershed MOA through which the City provided $500,000 in funding. The program is administered by the WAC, since approximately 36% of farms in the WAP is forested (1997 WAP Evaluation). The program works towards minimizing nonpoint pollution due to forestry activities by using management practices and maintaining well-managed forests as a preferred land use. An evaluation of this program can be found in Chapter VI.

Agricultural Easement Program

The Watershed MOA allows for $10 million of funds set aside for the Land Acquisition Program to be used for the Purchase of Agricultural Conservation Easements (PACE) Program. Easements obtained under this program are not credited toward the Land Acquisition Program solicitation goals. PACE is administered by the WAC. To be eligible for PACE, the landowner is required to have a Whole Farm Plan in place. Easements are prioritized based on size, presence of streams, distance to reservoirs, development potential and other natural or cultural resources. The program is underway with land use planning complete for eight of the ten pilot farms.

4. Conclusions/Recommendations

The WAP is a watershed protection program which has been successful in several areas. The program has implemented several management practices which are widely accepted as having the potential for reducing agricultural pollutants and resulting runoff. The program addresses a broad geographic area which is a significant source of pathogens, phosphorus and sediment. A satisfactory level of implementation of the program has been achieved, as demonstrated through voluntarily participation on almost 90% of watershed farms and through implementation on approximately 73% of farms with approved plans.

The WAP has supported several scientific research projects to justify and improve the management practices used in Whole Farm Plans. Ongoing research throughout the country as well as research and monitoring projects within the watershed are expected to continue to provide information for improvements in management practices.

Quantification of the actual contaminant load reductions resulting from the WAP is a long-term objective. Meeting this objective poses difficulties due to the complexities of monitoring non-point source pollution. However significant efforts are being made. A monitoring program is in place to measure water quality at one farm and additional monitoring to evaluate management practices is scheduled to begin this year. **EPA recommends that NYCDEP and the WAC continue to support and seek funding for additional monitoring to quantify the reductions in non-point source pollution achieved through the implementation of management practices recommended in Whole Farm Plans.** Such monitoring should address individual management practices as well as reductions on the whole farm scale, and results should be used to improve plan development. These monitoring efforts will provide valuable information to assess the effectiveness of the WAP and will provide data for use in modeling reductions for use in the biennial FAD evaluation of the WAP.

Monitoring and modeling are the tools that will ultimately measure the success of the WAP. **EPA recommends that NYCDEP continue to develop modeling programs to evaluate the overall impact of the WAP on water quality.**

In 1998, FAD requirements were modified to recognize the need for an increased emphasis on implementation. **EPA recommends that NYCDEP and WAC develop an effective mechanism for prioritizing implementation, both among farms and within an individual Whole Farm Plan.** The 1998 modification also recognized the need for follow-up visits to the farms with Whole Farm Plans already in place. **EPA recommends that NYCDEP and the WAC continue to provide technical support to participating farmers since several practices require long-term implementation and plans may need modification over time**.

The WAP might provide additional water quality protection if it were expanded to farms that do not meet the current WAP definition of a "farm" ($10,000 or more gross income attributable to farming activities). **EPA recommends that NYCDEP and WAC evaluate the possible benefits of such an expansion versus the addition effort to implement an expanded program**.

During the public comment period, questions were raised regarding the adequacy of the definition of "Whole Farm Plans Complete." The deliverable refers to Whole Farm Plans which have been substantially completed by implementation of management practices to address nine out of eleven pollutant categories. This definition is based on the understanding that behavioral changes, such as those required to implement nutrient management plans, are ongoing and that structural management practices may require over a year to construct. **EPA recommends that NYCDEP and WAC consider modifying the definition of "Whole Farm Plans Complete" to ensure that the**

remaining approved management practices will be implemented and follow-up technical support will be provided.

V. Kensico Modeling and Remediation Program

Program Objective

The Kensico Reservoir, in central Westchester County, is the terminal reservoir for the City's Catskill/Delaware water supply system. Under normal operating conditions, almost all water from the Catskill/Delaware watershed (which supplies 90% of the City's water) flows through the Kensico Reservoir prior to being chlorinated and sent to the City via the Catskill and Delaware aqueducts. As a terminal reservoir, Kensico is subject to the objective criteria of the Surface Water Treatment Rule (SWTR), which contains standards for fecal coliform and turbidity levels for unfiltered water supplies. The overall objective of the Kensico Modeling and Remediation Program is to improve water quality in the Kensico Reservoir by identifying sources of these contaminants and instituting appropriate source prevention and remediation measures.

Background

Water leaving Kensico Reservoir has never violated the coliform bacteria source water requirements of the SWTR since they took effect in 1991. However, in the autumn-winter periods from 1991 through 1993, elevated levels of fecal coliform threatened compliance and caused the City to bypass Kensico Reservoir. Thus, the only way compliance with SWTR and filtration avoidance criteria was maintained was by not utilizing Kensico Reservoir for part of the year. Bypassing Kensico was not seen as a long-term solution because the two through four week water residence time offered by the reservoir is often necessary to remove turbidity and coliform bacteria from upstate sources. Moreover, it provides additional time for bacteria to die-off. Thus, a critical element of EPA's first Filtration Avoidance Determination (FAD - January 1993) was the requirement that NYCDEP commission a watershed protection study to address the problem of microbiological contamination in Kensico Reservoir. To maintain filtration avoidance, the City had to identify and control the sources of fecal coliform bacteria in Kensico.

In March 1993, NYCDEP completed the Kensico Watershed Study (FAD deliverable 14f) which found that waterfowl and gulls were a significant source of fecal coliform bacteria to the reservoir. In response, the City began its Waterfowl Management Program in 1994 and saw dramatic decreases in fecal coliform levels in the Kensico Reservoir. (The City has not had to bypass Kensico for water quality purposes since 1993.) As a follow-up to the above study, the City initiated a comprehensive Kensico Water Pollution Control Study (FAD deliverable 307b), to assist the City in identifying and mitigating the sources of coliform bacteria, turbidity and other pollutants in the Kensico watershed. The study included numerous elements, each of which was subject to its own report. Potential non-point sources of pollution (sewers, septic systems, hazardous spills and stormwater runoff) were evaluated. Other activities included groundwater and sediment monitoring, an extensive evaluation of existing

coliform data, a wetlands analysis, and stream and reservoir modeling. The final report[20] was submitted in May 1995 and contained specific recommendations to address the potential coliform bacteria sources and turbidity. These recommendations were later memorialized in the City's Kensico Reservoir Water Quality Control Program (KRWQCP)[21] and became important elements of EPA's 1997 FAD. They included:

- Stormwater control - structural and non-structural stormwater management practices for reducing discharges of coliform and suspended solids from priority streams,
- Sediment dredging around Delaware Shaft 18 and the Catskill Upper Effluent Chamber,
- Installation of a temporary curtain wall between the Catskill Upper Effluent Chamber and Malcolm Brook, and
- Waterfowl and gull management.

In accordance with the FAD, the City has instituted the following additional Kensico programs:

- Wastewater Evaluation and Control,
- Groundwater Monitoring,
- Surface Water Monitoring (reservoir and streams),
- Kensico Water Quality Model, and
- Public Education and Outreach.

The FAD mid-course evaluation will examine each of these nine Kensico programs individually.

1. Kensico Stormwater Control Program

A. Program Objective

The objective of the Kensico Stormwater Control Program (KSWCP) is to identify and remediate the sources of fecal coliform bacteria and turbidity being conveyed to the Kensico Reservoir by stormwater runoff. This is one of the four programs recommended in NYCDEP's 1995 Kensico Water Pollution Control Study. Under the KSWCP, identified sources of contamination are mitigated through stormwater best management practices (BMPs). These stormwater BMPs consist of structural and non-structural stormwater controls. Success will be measured by the City's installation of all required

[20] *Kensico Reservoir Integrated Report and Comprehensive Plan* (Roy F. Weston, May 1995)

[21] *Kensico Reservoir Water Quality Control Program Final Environmental Impact Statement* (NYCDEP, December 1995)

BMPs and by measurable reductions in pollutants from stream discharges.

B. Program Description

The KSWCP calls for the mitigation of fecal coliform bacteria and turbidity through the implementation of stormwater BMPs. Stormwater BMPs proposed under this program can be segregated into two classes: (1) **source reduction** and (2) **pollutant removal**. Source reduction BMPs are intended to prevent stream contamination, generally by diverting stormwater flow and stabilizing areas subject to erosion. BMPs include: outlet stilling basins, check dams, stream bank stabilization, rolled bituminous curbing, and spill containment. Pollutant removal BMPs are intended to (1) reduce the velocity of stormwater discharges thereby allowing particles to settle out, and (2) detain fecal coliform bacteria allowing them to die off. Pollutant removal BMPs include: extended detention basins, oil/water grit separators and stormwater sand filters.

Location of the **source reduction** stormwater BMP sites was primarily based on the extent of existing erosion in each sub-basin. Those sub-basins with extensive streambank and streambed erosion contributed excessive levels of turbidity and, therefore, were prioritized for source reduction BMPs. NYCDEP developed the following criteria to pre-screen sub-basin sites for implementation of the proposed **pollutant removal** stormwater BMPs:

- Proximity of the sub-basin to the reservoir effluent chamber;
- Source of fecal coliform bacteria or turbidity identified upstream of the BMP site within the sub-basin;
- Quality/quantity of the stormwater runoff draining to the BMP site within the sub-basin based on EPA's SWMM modeling predictions;
- Topography suitable for the construction of a water quality enhancement BMP;
- Erosion problems present in or adjacent to the streams within the sub-basin; and
- Wetlands present and suitably located to receive runoff draining to the wetlands for final water quality polishing.

Based on the proximity of the Malcolm Brook and Young Brook sites to the Catskill Upper Effluent Chamber they were assigned the highest priority and were scheduled first for remediation.

Under the KSWCP, the City originally proposed to implement 77 stormwater BMPs and 11 in-reservoir spill containment facilities (to prevent accidental hazardous material spills from entering the Kensico Reservoir via Interstate 684 storm drains). During 1996 and 1997, the City conducted a more rigorous analysis of existing topography and hydrologic patterns within the watershed. The goal of this analysis was to develop the best combination of strategically placed stormwater BMPs to improve water quality and to reduce the BMPs' impacts on the surrounding environment. Factors included pollutant removal potential, site constraints, access to private property, and ease of maintenance. The analysis led to modifications to the configuration and size of existing BMP sites, the

identification of new locations and the deletion of other locations. The revised KSWCP included a total of 44 stormwater BMPs on 32 sites in 16 sub-basins at an estimated cost of $17 million. (The 77 BMPs in the original plan effected 20 sub-basins.) The 44 stormwater BMPs include 10 extended detention basins.

C. Program Assessment

i. Implementation - In accordance with FAD Task 307c-1, in February 1997 the City submitted a schedule for construction of the stormwater BMPs. FAD Task 307c-2 requires the City to initiate construction of BMPs in accordance with the implementation schedule. The City divided the program into three phases. These phases and their construction status are described in Table V.1, below.

Table V.1 - Status of Kensico Stormwater BMPs*

Project	Description	Status
Phase I	Six facilities located in the Malcolm Brook and Young Brook sub-basins	Construction began in April 1999 and was completed November 1999.
Phase II	One facility (Extended Detention Basin) on Pepsico Property located at the headwaters of Malcolm Brook	Construction contract was awarded and pre-award meeting with contractor was held November 1999. Construction is scheduled to begin in Spring 2000.
Phase III	Thirty seven facilities located in sub-basins N2 through E11	Construction began October 1999. Nine facilities have been completed. Four are under construction. Completion of Phase III is expected by the end of 2000.

* 44 stormwater BMPs

Construction of Phase I, which includes six facilities in the high-priority Malcolm Brook sub-basin, was delayed over a year. According to NYCDEP, the schedule was compromised due to problems in obtaining final designs and cost estimates from the contractor. However, once construction began, it proceeded quickly; Phase I was completed approximately six months behind schedule. The delay did not lead to any degradation of water quality as measured at the Catskill Upper Effluent Chamber and Shaft 18, most likely due to the success of the short-term remediation measures required under FAD 307m (Turbidity Curtain - see Section 3). Phases II and III of this project (see Table V.1 above) are moving ahead expeditiously. A contract has been awarded for both phases, and a contractor is in the field installing BMPs. The City continues to closely monitor and report on progress to EPA. By the end of 1999, the City had built 15 facilities and had begun construction on another four. Based on the contractor's schedule the City believes that it can complete the remaining

stormwater BMPs and the 11
in-reservoir spill containment facilities by the end of 2000. If NYCDEP can meet this objective, it will complete the KSWCP far ahead of the schedule laid out in FAD Task 307c-1 which contained a completion date of August 2002.

Proper operation and maintenance of the stormwater BMPs (particularly extended detention basins) are essential to their effectiveness. By December 1999, the City had drafted a *Stormwater BMP Operation and Maintenance Handbook* for use by NYCDEP field staff. This manual is currently undergoing internal review by NYCDEP engineering. Upon approval by EPA the City's performance relative to this manual will be examined during the second half of the 1997 FAD.

ii. Water Quality Improvement - Success of the KSWCP will be measured by improvements in the levels of turbidity, coliform bacteria, *Giardia* cysts and *Cryptosporidium* oocysts discharging into the Kensico Reservoir. Selected streams in the Kensico basin have been intensively monitored since 1995 to establish the baseline water quality conditions. These streams have been monitored on a routine basis (fixed frequency) and during special events
(e.g., rainstorms and snow melt). According to NYCDEP, stream monitoring data from 1995 through 1998 (for both fecal coliform bacteria and turbidity loadings) show that during that period storm events accounted for over 80% of the total bacteria loading to the Kensico Reservoir (FAD deliverable 307p, July 1998). To evaluate BMP effectiveness and removal efficiencies, baseline data will be compared to data obtained after BMPs are installed. In 1999, the City completed a five-year monitoring plan to assess BMP treatment effectiveness and removal efficiencies by monitoring upstream and downstream of selected BMPs. Next, it will compare these data with pre-BMP baseline data. NYCDEP expects to begin to implement this plan during April 2000 with the completion of the Malcolm Brook and Young Brook stormwater BMP sites. As additional stormwater BMP sites are completed, the monitoring program will be expanded. EPA will actively track the results of this monitoring effort during the second half of the 1997 FAD.

D. Conclusions/Recommendations

NYCDEP's implementation of the KSWCP is an important step in enhancing water quality in the Kensico Reservoir. The Program addresses fecal coliform bacteria and turbidity that discharges into the reservoir via stormwater through a number of source control and pollutant removal BMPs. Although the City was late implementing Phase I of the Program, it expects to complete the entire Program by the end of 2000, well before the completion date specified in FAD
(mid-2002). EPA commends NYCDEP for expediting construction and pursuing an aggressive target completion date of 4th quarter 2000 for the entire Kensico Stormwater Control Program.

Long-term success of the KSWCP will be gauged by water quality improvement in stormwater flow entering the Kensico Reservoir. Thus, evaluating the effectiveness of the Kensico stormwater BMPs is critical. NYCDEP recently completed a stormwater monitoring plan for this purpose. **EPA**

recommends that the City implement its stormwater monitoring plan and include the results, with analysis, in the semi-annual Kensico Report (307p) submitted to EPA. In addition, the City should periodically provide EPA information on operation and maintenance activities (conducted pursuant to its *Inspection and Maintenance Handbook*) conducted on the stormwater BMPs. As this program moves into the implementation and monitoring phase, EPA will continue to evaluate whether additional BMPs are necessary to protect the Kensico Reservoir.

2. Kensico Maintenance Dredging Program

A. Program Objective

The objective of the Kensico Maintenance Dredging Program is to remove accumulated sediment in the vicinity of the Kensico Reservoir's chambers (Shaft 18 and the Catskill Upper Effluent Chamber [CUEC]), thereby eliminating a potential public health risk to drinking water consumers. Storm events may cause the resuspension of accumulated sediments that are in proximity to Shaft 18 or CUEC. The resuspended sediment, which may harbor pathogens, could be drawn into the City's distribution system and pose an immediate health concern. Elimination of this sediment removes the associated human health risk. Program success is determined by the effective removal of accumulated sediment.

B. Background

The Kensico Water Pollution Control Study, performed under the 1993 FAD (FAD Task 307v), concluded that sediment adjacent to Shaft 18 and the CUEC was a potential source of turbidity and fecal coliform bacteria which, if resuspended during storm events, could contaminate the City's water supply. EPA agreed with this assessment and, at NYCDEP's suggestion, incorporated the dredging of this sediment as a requirement in the 1997 FAD (Task 307c-3). Supported largely by NYCDEP visual observations, the Study suggested that over the years, sediment emanating from Malcolm Brook and Young Brook settled in the masonry channels leading to the Kensico's chambers, at the shoreline by the CUEC and at the deltas of both brooks. Since Malcolm Brook and Young Brook discharge within 500 feet of the CUEC, the potential for a storm event increasing turbidity levels at CUEC was significant and therefore threatened public health. Recognizing this concern, EPA considered removal of this sediment to be a prudent health protection measure.

C. Assessment

i. FAD Task Compliance - Under 1997 FAD Task 307c-3, NYCDEP was required to complete the Kensico Maintenance Dredging Program by the end of October 1998. The City successfully completed the Program on May 12, 1999, approximately six months late. In response to EPA's February 1999 letter questioning the slippage in schedule, the City informed EPA that reasons for the

delay included contractual problems coupled with delays in obtaining the necessary State and local approvals.

ii. Program Implementation - In order to comply with the FAD, the NYCDEP developed two separate contracts. The scope of the first contract was twofold: (a) to determine the exact location and volume of sediment to be removed and (b) to gather and analyze sediment samples to determine the appropriate handling and disposal method. The scope of the second contract included the actual dredging, dewatering, transportation and disposal of the accumulated sediment.

In spring 1998, divers conducted visual inspection of the Kensico masonry intake channels and adjacent areas to estimate the volume of sediment and gather sediment samples. Inspection results were reported to the City in June 1998. The sediment was classified by NYSDEC as non-hazardous and suitable for disposal in a landfill. Once NYSDEC awarded the City a Protection of Waters Permit (September 1998), NYCDEP began preparation of the dredging contract. The contract was awarded in January 1999. To protect divers from being pulled into the Kensico chambers and to prevent sediment suspended from the dredging process from contaminating the distribution system, each chamber was on full reservoir bypass during the dredging operation. Dredging was completed at Shaft 18 in April 1999 and at the CUEC in May 1999. (Dewatered sediment was hauled offsite to an approved landfill in Maryland.) The total volume of dredged material removed from the two Kensico Reservoir chambers was approximately two times greater than anticipated (see Table V.2, below).

Table V.2 - Estimated Volume of Sediment vs Actual Volume of Sediment Removed

Location	Estimate Volume yds^3	Actual Volume Removed yds^3
Shaft 18	420	451.3
CUEC	560	1325.7
Totals	980	1777.0

EPA and NYSDOH inspected the dredging operation in April 1999 and were satisfied that adequate safeguards were being utilized and that the raw water source was being protected.

D. Conclusions/Recommendations

Although NYCDEP was approximately six months late in implementing the Kensico Reservoir Maintenance Dredging Program, the Program was completed and the FAD objective was satisfied. By removing the sediment adjacent to Shaft 18 and the CUEC, the City eliminated a potential source of

turbidity and fecal coliform bacteria which, if resuspended during storm events, could have contaminated the City's water supply. **As a long-term operation and maintenance measure, EPA recommends that the NYCDEP perform periodic inspections (e.g., 5- to 10-year frequency) to determine the extent of sediment buildup over time and to assess the need for renewed dredging. Inspections should include the masonry channels leading to Kensico's chambers, the shoreline adjacent to the CUEC and the deltas of both Malcolm and Young Brooks.**

3. Short-Term Remediation Measures for Malcolm Brook

A. Program Objective

The objective of this Program, instituted in 1994 and 1995, is to provide interim and immediate protection to Kensico Reservoir from turbidity and fecal coliform bacteria contamination emanating from Malcolm Brook prior to the implementation of permanent stormwater BMPs at Malcolm Brook and Young Brook (see Section 1). The two short-term remediation measures include minor erosion control devices along Malcolm Brook and a turbidity "curtain wall" between Malcolm Brook and the CUEC. Success of this Program is measured by water quality data in Kensico Reservoir on either side of the curtain wall, near the CUEC and Shaft 18.

B. Background and Program Description

Due to the proximity of the CUEC to the mouths of Malcolm Brook and Young Brook (500 feet), NYCDEP has long considered stormwater from Malcolm Brook a significant threat to the City's water supply. EPA shared the City's concern and, through the 1993 FAD (deliverable 307m), required NYCDEP to identify and evaluate immediate short-term remediation measures for reducing contamination emanating from the two brooks into Kensico Reservoir. These measures were intended to immediately address turbidity, recognizing that the City would also be implementing a long term turbidity reduction strategy through implementation of the Kensico Reservoir Stormwater Control Program.

Short-term remediation measures provided by NYCDEP, under the 1993 FAD, included silt fencing, erosion control matting, hay bale dams (installed in 1994) and an 850 foot-long turbidity curtain wall (installed in 1995). The silt fencing controls erosion by temporarily directing stormwater runoff away from severely eroded stream banks; erosion control matting retards additional bank erosion and provides a foothold for vegetative cover. Stormwater runoff velocity (and its erosive potential) is reduced through the utilization of the hay bale dams. Installation of an 850-foot-long turbidity curtain at

the mouth of Malcolm Brook and Young Brook was a key element of the short-term remediation measures provided. The curtain directs any turbidity or coliform bacteria away from the CUEC. Under the 1997 FAD, these measures are expected to be maintained until permanent stormwater management facilities are completed, at which point they are to be removed.

C. Program Assessment

i. FAD Task Compliance - The City adequately reports on performance and maintenance issues related to the short-term remedial measures through FAD Task 308i.

ii. Program Implementation - As reported in 308i, the turbidity curtain and Malcolm Brook mitigation measures received regular inspections by NYCDEP field personnel. Periodically, replacement of hay bales, reinforcement of silt fencing and minor repairs to the curtain wall fabric were necessary. Much of the silt fencing, erosion control matting and hay bale dams in Malcolm Brook were removed in 1999 when permanent stormwater BMPs were installed. The turbidity curtain remains.

iii. Water Quality - The water quality data reported by the City (in FAD Task 307p) confirm the success of the turbidity curtain wall. Water samples collected on either side of the wall during storm events confirmed that it was effectively protecting CUEC and Shaft 18 from elevated turbidity emanating from Malcolm and Young Brooks.

D. Conclusions/Recommendations

The short-term remediation measures have performed as expected, offering immediate protection to distribution system intakes (CUEC and Shaft 18) at the Kensico Reservoir. When Phase II of the KSWCP is completed (estimated to be mid-2000), all of the permanent BMPs for Malcolm Brook and Young Brook will be in place. At that time, remaining hay bales and silt fencing will be removed. **EPA recommends that, since the curtain wall has been shown to be an effective turbidity barrier, the City include the curtain wall as a permanent BMP structure.**

4. Waterfowl Management

A. Program Objective

Gull and waterfowl roosting near the effluent chambers and other areas of Kensico Reservoir were found to be the dominant source of fecal coliform bacteria loading in the reservoir. The objective of the City's Waterfowl Management Program is to eliminate roosting birds from the Kensico Reservoir during the migratory season, thereby eliminating a significant source of contamination to the reservoir and substantially improving water quality.

B. Background and Program Description

In 1991, 1992 and 1993, the Kensico Reservoir was bypassed during the autumn and early winter due to high levels of fecal coliform bacteria. The City conducted a number of studies in the early 1990's to determine the causes of fecal coliform loading. EPA's January 1993 FAD (Task 14f) required that the City integrate these studies and develop an updated comprehensive strategy to address contamination in the Kensico Reservoir. This resulted in the City's Kensico Watershed Study (1991-1993) which concluded that waterfowl (primarily Canada geese) are the primary source of fecal coliforms. Intensive follow-up work, directed through EPA's December 1993 FAD, confirmed and built upon these findings. As a result, the City instituted a Waterfowl Management Program in late 1993.

The City conducts waterfowl surveys at five reservoirs: Kensico, Hillview, Rondout, Ashokan and West Branch. They are conducted for several purposes:

- to monitor roosting bird populations;
- to establish the relationship between fecal coliform and bird populations;
- to monitor effectiveness of waterfowl deterrents at Kensico and Hillview;
- to determine the need for waterfowl deterrents at West Branch, Ashokan and Rondout; and
- to collect fecal samples to determine potential pollutant loads of coliform and pathogens.

C. Assessment

i. FAD Task Compliance - Task 307 l-1 requires that NYCDEP continue implementation of the final Waterfowl Management Plan and submit annual reports. Implementation is continuing and annual reports are submitted. The information provided in the reports is comprehensive and allows for Program evaluation.

ii. Program Implementation - Since implementation of this Program, fecal coliform bacteria levels have decreased significantly in the fall-winter months and seasonal bypassing of Kensico has not been necessary. The program includes bird hazing and egg-depredation. Hazing is conducted from October through March, targeting all non-threatened and non-endangered species. Egg-depredation has decreased the number of Canadian geese nests in the Kensico watershed from 70 in 1992 to 41 in 1998. In 1998, 316 eggs were addled with one young goose recorded as hatching. During the 1995/1996 bird hazing season, 81 surveys were conducted to record waterfowl and gull populations. Data show an 85% to 95% decrease in birds from the 1993 population during the months of August, September and October. Surveys are conducted annually and continue to show similar results.

D. Conclusions/Recommendations

The Waterfowl Management Program continues to significantly decrease the number of waterfowl in the Kensico watershed. An associated improvement in water quality was observed at the onset of the program and continues to be maintained. The City has noted (Kensico Watershed Study, July 1996) that Rondout and West Branch Reservoirs show seasonal waterfowl population increases similar to those seen at Kensico and that these increases seem to coincide with increases in coliform levels entering Kensico. Although compliance with the SWTR does not seem to be threatened by upstate sources of coliform, control in these reservoirs is also important. **To continue to reduce the risk of fecal coliform bacteria loading in the Catskill/Delaware system, EPA recommends that NYCDEP implement a Waterfowl Management Program in the Rondout and West Branch Reservoirs.**

5. Wastewater Evaluation and Control

A. Program Objective

The objective of this Program is to eliminate untreated wastewater as a potential source of contamination in the Kensico watershed. This is to be accomplished by (1) addressing failing septic systems, (2) ensuring that all septic systems in areas with available sanitary sewers are connected to those sewers, and (3) identifying and repairing all defective sewer lines.

B. Background

EPA's January and December 1993 FADs included a number of tasks requiring NYCDEP to evaluate and remediate potential sources of wastewater contamination to Kensico Reservoir. In accordance with the December 1993 FAD, the City completed a detailed inventory of all septic systems in the Kensico watershed. NYCDEP identified the Jenny Clarkson Home, a facility serving over 300 people, as having a failing septic system that needed to be addressed. Due to the large size of the facility and the geology of the area, connection to a sewer was required (necessitating the creation of a sewer district and the construction of a trunk main). This connection became a 1997 FAD commitment. In the mean time, NYCDEP was required monitor the Jenny Clarkson facility to assure pump-outs were done at adequate intervals to prevent overflow or system failure, until sewer service connection was completed. NYCDEP also identified 16 residential properties with septic systems which are required by Westchester County's Sanitary Code to connect to the public sanitary sewer. These connections also became a 1997 FAD commitment. Finally, NYCDEP developed and implemented a sewer inspection strategy in the Kensico watershed. The inspections and evaluations were completed in December 1996. All necessary repair and reconstruction work became subject to 1997 FAD.

C. Assessment

NYCDEP identified 16 residential properties with septic systems which are required by Westchester County's Sanitary Code to connect to the public sanitary sewer. In accordance with deliverable 307e

of the 1997 FAD, NYCDEP submitted a protocol to Westchester County for connection of all septic systems to sanitary sewers. However, the protocol with the County was never finalized. NYCDEP reported that it made several attempts to meet with Westchester County Department of Health from summer 1997 through spring 1999 on this issue; none were successful. To date, these sewer connections have not been established and therefore the objective of FAD Task 307e-1 has not been met.

FAD Tasks 307g-1 through g-3 required the City to provide weekly pump-outs and fund a new municipal sewer line from the failed Jenny Clarkson community septic system to a municipal WWTP by mid-1997. NYCDEP ensured that weekly pump-outs were performed until municipal sewer service connection was completed in December 1997. NYCDEP submitted a final confirmation report on December 29, 1997 satisfying its responsibility under Task 307g.

Tasks 307i and 307j require NYCDEP to identify and rehabilitate unreliable sewers within the Kensico Reservoir watershed, with the highest priorities being those closest to the reservoir and those in the Malcolm Brook sub-basin. The program concluded that 39 pipe segments totaling approximately 8,000 linear feet and three manholes required repair or replacement to prevent potential exfiltration. Task 307j requires all identified sewer leaks to be repaired within 12 months from identification. As of September 1998, all repairs had been completed; therefore, the City has satisfied the objectives of FAD Tasks 307i and 307j. As noted below, EPA believes an operation and management agreement with the Counties should also be established to ensure continued reliability of the sewer systems around Kensico.

D. Conclusions/Recommendations

FAD Task 307e-1 required a protocol between NYCDEP and the appropriate county or town to ensure that septic systems in sewered areas are disconnected and connected to sewers. The City identified 16 residences that under Westchester County's sanitary code require such a hookup. For the past two years, NYCDEP has been unsuccessful in finalizing a protocol with Westchester County. Therefore, this FAD objective has not been met. Although none of these septic systems are currently failing, connecting them to existing sewers is a prudent health protection measure because, in the long-term, it will prevent potential microbial and nutrient contamination of the Kensico Reservoir. **EPA recommends that NYSDOH, on behalf of the City, work with Westchester County to enforce its sanitary code to ensure that 16 residences currently on septic systems are connected to the existing sewer system.**

EPA commends the City for completing a comprehensive sewer inspection and rehabilitation program. **To ensure the long-term reliability of sewers within the Kensico Reservoir watershed (and in other Cat/Del watersheds), EPA recommends that NYCDEP work with Westchester and Putnam Counties to develop an Operation and Maintenance (O &M) agreement. The City should report in its FAD annual report on its continuing efforts to identify and repair sewer system defects in the watershed.**

6. Kensico Groundwater Monitoring Program

A. Program Objective

The objective of the Kensico ground water monitoring program is to determine the contribution of ground water to pollutants entering the Kensico Reservoir. Potential sources of concern are septic systems and leaking sewers.

B. Background and Program Description

As part of its Kensico Reservoir Water Pollution Control Study (1994) and FAD Task 307v-8 (December 1993), NYCDEP evaluated the potential for fecal coliform and chemical transport via ground water to the reservoir. It installed 18 monitoring wells at 13 locations in the Kensico watershed. Initial sampling confirmed contamination downgradient from the Jenny Clarkson Home (see Section 5, above). A long-term ground water monitoring program began in April 1995.

C. Assessment

i. FAD Compliance and Implementation - NYCDEP continued the ground water monitoring program outlined in the December 1994 Kensico Long-Term Monitoring Plan through April 1997. In July 1997, the City submitted an analysis of the data and recommendations for future groundwater monitoring (Task 307v-8b). EPA agreed that due to consistently high ground water quality, a reduction in sampling frequency from monthly to bi-yearly (winter and summer) would be appropriate.

ii. Water Quality - As detailed in previous NYCDEP reports, the overall ground water contribution to the reservoir is extremely small. Water elevations in the wells were similar to those of the reservoir or nearby streams. Fecal coliform bacteria detections in monitoring wells typically occurred one or two days after a rainfall, indicating that surface water infiltration was the source. The well with the highest counts of fecal coliform in 1995 was located downgradient of the Jenny Clarkson site. Nutrients in the wells did not exceed Ambient Water Quality Standards and did not fluctuate greatly over the two years of sampling. Detention basins are being constructed at several of the monitoring well sites which will address the surface source of contamination (see Section 1).

D. Conclusions/Recommendations

The Kensico Ground Water Monitoring Program has confirmed previous NYCDEP studies by demonstrating that ground water is not a significant source of contamination to the reservoir. NYCDEP is continuing to monitor ground water wells on a semi-annual basis. In the event that elevated levels of fecal coliform bacteria or nutrients are observed, NYCDEP has stated that it will increase sampling frequency. **EPA recommends that NYCDEP specify the levels of increased concentrations of**

fecal coliform bacteria and nutrients that would trigger additional ground water monitoring.

7. Kensico Surface Water Monitoring Programs

A. Objectives

Due to its status as the primary terminal reservoir in the Catskill/Delaware system, NYCDEP conducts an intensive water quality monitoring program in the Kensico Reservoir and its tributaries. There are several objectives of the monitoring programs:

- to ensure compliance with the Surface Water Treatment Rule (SWTR),
- to quantify and evaluate potential sources of pollution,
- to evaluate relative loadings of different pollution sources,
- to evaluate the effectiveness of remediation efforts and protection programs, and
- to support Kensico model development.

B. Program Description

Surface Water Treatment Rule compliance samples are collected daily at each of the two points where water leaves the reservoir and enters the distribution system (Shaft 18, Catskill Upper Effluent Chamber [CUEC]). Routine samples are also collected daily at the reservoir's six "keypoints" (which also include the two SWTR compliance sites) where water either enters or leaves the reservoir. Additionally, NYCDEP collects routine limnological (reservoir) samples at 11 fixed sites throughout the Kensico Reservoir. These sites are generally sampled on a monthly basis for approximately 30 physical, chemical and biological parameters. NYCDEP conducts more frequent sampling to investigate specific water quality concerns. Details on Kensico monitoring analytes and sampling frequency can be found in the 1998 Kensico Watershed Study Annual Research Report (FAD Task 307p).

NYCDEP has established a stream monitoring network within the Kensico watershed. This network consists of four continuously monitoring discharge stations, four rain gauges and one meteorological station. In addition, each of the eight perennial streams discharging into the Kensico are sampled monthly. Sampling includes fixed frequency (reduced from weekly to monthly as of January 1999) and storm events.

In addition to the physical, chemical and biological parameters measured at these sites, pathogens (*Cryptosporidium*, *Giardia* and enteric viruses) are monitored weekly at Kensico's influent and effluent chambers and at the mouth of Malcolm Brook. If turbidity samples exceed 1.5 NTUs in the reservoir, sampling frequency is increased to daily at the two effluent chambers. Three upstream sites on Malcolm Brook are monitored monthly and are equipped with automated samplers to allow for sampling during

storm events.

C. Assessment

i. FAD Task Compliance - Task 307n-1 requires NYCDEP to continue operation of continuous recording flow meters and rain gauges on tributary creeks in the Kensico basin. Notification of changes in location and equipment needs must be provided to EPA. NYCDEP has complied with this requirement. NYCDEP also reports on its monitoring efforts in the Kensico Watershed Study Annual Research Report as required by deliverable 307p. (An assessment of the City's SWTR compliance monitoring program can be found in the Chapter I [Objective Criteria] of this report.)

ii. Implementation - The City has extensively monitored the Kensico watershed for the past several years. Much of the data is used to determine compliance with the SWTR objective criteria; however, data are also collected to meet a number of other objectives (see above). These data have provided the City with a good database of water quality conditions from which to develop and implement watershed management practices. The City's Kensico Stormwater Control Program (Section 2), Malcolm Brook turbidity curtain (Section 3), and Waterfowl Management Program (Section 4) are examples of how monitoring data have been and will be used to implement and evaluate watershed management practices.

A comparison of results from storm event monitoring and fixed frequency monitoring highlights the importance of storm event monitoring when quantifying contaminant loads. Fecal coliform loads (peak values and event mean concentrations) differed at sites depending on whether samples were collected during storm events or at fixed frequencies. For example, under baseline flow conditions, coliform concentrations did not vary by more than one order of magnitude among Kensico sub-basins. However, storm event sampling during fall 1995 indicated that Malcolm Brook consistently delivered the highest coliform loads, both on a total fecal coliform loading basis and on a per acre of watershed basis. (Malcolm Brook is in one of the smallest Kensico sub-basins.) The City stated that "although [the Malcolm Brook sub-basin] is small, the amount of impervious surface from roads and parking lots allows a high percentage of the precipitation that falls to become direct runoff."[22] NYCDEP concluded that the amount of impervious surface and development correlated well with coliform concentrations in streams during storm events.

Throughout the 1997 FAD, the City complied with EPA's objective criteria at the two aqueduct keypoints (Shaft 18 and the CUEC). We note however, that during the 1998/1999 reporting period, NYCDEP's self imposed guideline for total (100/100 ml) and fecal (20/100 ml) coliform, within the reservoir, was exceeded thirteen and six times respectively. As in previous years, the high levels occurred in mid-August through September. The elevated fecal coliform concentrations were attributed to increased waterfowl activity and storm events.

[22]Kensico Watershed Study Annual Research Report - April 1995 - March 1996 (NYCDEP, 1996)

D. Conclusions/Recommendations

The City effectively utilizes an extensive amount of monitoring data in the Kensico basin to make watershed management decisions. **Because of the critical information storm event monitoring provides, EPA recommends that the City continue and expand its storm event monitoring program (including the analysis of pathogens) to support a number of Kensico remediation and modeling activities.**

8. Modeling

A. Program Objective

NYCDEP has developed a Kensico Water Quality Model which can predict temperature, water velocity, coliform concentrations and suspended solids at 3116 points in the reservoir (1993 FAD Task 307v-17). The three-dimensional model can be used to predict travel time through the reservoir, fate and transport of pollutants and the degree of influence of various streams on water quality. The primary objective of model development is to aid the City in choosing among various modes of reservoir operations to maximize water quality in the distribution system. It can also be used as a watershed management tool.

B. Program Assessment

i. FAD Task Compliance - Up until July 1998, NYCDEP provided adequate updates on Kensico modeling efforts in the Kensico Watershed Study Annual Research Report (Task 307p). There have been no updates since that time.

ii. Implementation - During the 1997/1998 reporting period, NYCDEP automated the model's post-processor output for use by the IBM Visualization Data Explorer. This enhancement produces an on-screen time-lapse visualization of reservoir events. The City demonstrated the model's use as a management tool by estimating transport distances of alum floc and turbidity in the reservoir to predict SWTR compliance. NYCDEP has identified a number of recommendations to improve the use of the Kensico model:

- enhancement of the user interface,
- education of NYCDEP staff,
- additional model input files, documentation and post-processors, and
- development of a two-dimensional model for enhanced use.

Despite NYCDEP's success in using the model as a management tool and recognizing that additional

work on the model would be beneficial, no activity on the Kensico model was reported during the 1998/1999 reporting period.

C. Conclusions/Recommendations

NYCDEP has expended significant resources in the development of the Kensico model. **EPA recommends that the Kensico Water Quality Model be utilized to predict water quality changes due to changes in stream loads following stormwater BMP implementation and as a management tool as opportunities arise.**

NYCDEP's Kensico Watershed Study Annual Research Report (July 1998 - Task 307p) suggested improvements to the Kensico Water Quality Model (KWQM). Of particular note, it recommended that a two-dimensional model be developed so that the KWQM could be compatible with the other ongoing Catskill/Delaware modeling efforts. **EPA recommends that NYCDEP establish compatibility with other Catskill/Delaware Multi-Tiered Water Quality Models.**

9. Public Education and Outreach

The City maintains two outreach programs in the Kensico watershed, one geared toward the residential community living in the watershed, and the other toward the corporations along the Route 120 corridor.

Kensico Environmental Enhancement Program

A. Objective

The objective of the City's residential community outreach program for the Kensico watershed, the "Kensico Environmental Enhancement Program" or "KEEP," is to provide the community with educational forums and materials to increase their understanding of the importance of the Kensico Reservoir.

B. Program Description

KEEP is a joint effort between the community and NYCDEP to prevent pollution of the Kensico Reservoir through coordinated patrols, citizen reporting and community education. A KEEP committee was formed to serve as a mechanism for NYCDEP and the community to share information, communicate concerns and develop programs.

C. Program Assessment

i. FAD Task Compliance - NYCDEP is required to annually report on the KEEP. This report is provided in FAD Task 901a.

ii. Implementation - Daily vehicle patrols of the Kensico Reservoir and its perimeter are conducted by NYCDEP to check for permit violations, trespassing and potential pollution. In addition, on summer weekends, the City patrols the reservoir by boat. Major streams entering Kensico are checked daily for signs of turbidity, petroleum or illegal discharges. In 1998, these patrols resulted in the issuance of 54 Notices of Warning, five trespass summonses, 809 fishing permit checks, 120 boating permit checks and several work orders for trash removal.

KEEP has developed a Reservoir Watch/Adopt-a-Stream Program. Through this program, residents of Whippoorwill, a large community in the Town of North Castle, received mailings informing them how they could participate in watershed protection activities. Mailings included a brochure entitled *Everyday Acts of Watershed Protection*, an invitation to participate in the Adopt-a-Stream Program and information on proper waste disposal. Additionally, a volunteer monitoring program was established for the Whippoorwill Stream. Community education includes activities such as wetlands walks and presentations on wetlands restoration and protection. The educational component also included a teacher's workshop on macroinvertebrate sampling.

Several improvements were made to KEEP during the past year. Prior to 1999, activities were focused in a limited area within the watershed. During the past year, KEEP meetings were held in various locations throughout the watershed, resulting in a more diverse set of participants. Also in 1999, NYCDEP began to design a permanent educational display for the Kensico Dam Plaza. The Plaza is used by many residents from the communities around the Kensico Reservoir. A high school internship program was also initiated.

D. Conclusions/Recommendations

KEEP has effectively opened communications between NYCDEP and the watershed community. **EPA recommends that the efforts made during 1999 to expand the program be continued and that NYCDEP continue to seek out innovative mechanisms to educate the Kensico community on the importance of watershed stewardship.**

Kensico Watershed Improvement Committee

A. Objective

The objective of the Kensico Watershed Improvement Committee (KWIC) is to reduce potential non-point source runoff to the Kensico Reservoir by developing sound environmental practices at corporate facilities along Route 120 in the Kensico watershed.

B. Program Description

The Town of North Castle established KWIC in 1997. Members of KWIC include representatives from the town and corporations located along the Route 120 corridor. In addition, NYCDEP, NYSDOT, and the Town's supervisor, engineer and attorney serve as advisors. In 1998, KWIC adopted a scope of work for a Route 120 Management Plan. Activities that will be addressed in the Management Plan include landscape and waterfowl management, stormwater runoff, de-icing materials, use and storage of hazardous materials and waste reduction.

C. Program Assessment

i. FAD Task Compliance - NYCDEP is required to annually report on the KWIC. This report is provided in Task 901a.

ii. Implementation - By the end of 1998, all but one KWIC corporate member prepared narratives describing corporate policies and practices for each of the issues to be included in the Management Plan. The narratives were reviewed by the co-chairs of the committee and NYCDEP resulting in a single set of standards and specifications applicable to each potential source of contamination. In 1999, a draft Management Plan was completed and circulated for comments. Once the Plan is approved, each member will be requested to adopt the Management Plan.

D. Conclusions/Recommendations

KWIC provides a mechanism for corporations along the Route 120 corridor to voluntarily address sources of non-point source pollution from their facilities. **EPA recommends that NYCDEP continue to actively support KWIC. In addition, EPA recommends that the City seek opportunities to build relationships with other towns and corporations located in the Kensico watershed.**

VI. Non-Point Source Control Program

1. Program Objective

The objective of the NYCDEP's Non-Point Source Control Program is to reduce or eliminate pollutant runoff from reaching the City's reservoirs and reservoir tributaries. Following the implementation of regulations to control point source discharges, non-point source pollution has become recognized nationally as the largest threat to the health of water bodies. Pollutants of concern include sediment, nutrients and pathogens. Non-point source pollution is generated from a diversity of different sources: failing septic systems, nutrient and pesticide application on landscaped and agricultural areas, inadequate road sand and salt storage, erosion from construction sites, unstable stream reaches and poorly managed timber operations, and runoff from impervious surfaces. Control strategies are dependent on the source, can be regulatory or non-regulatory, and typically contain a strong public education component. Indicators of program success include the level of implementation and public acceptance. The success of these programs is ultimately measured through either the maintenance of high water quality or an improvement in impaired waters, which is documented by monitoring data or modeling results.

2. Assessment

A. FAD Compliance

The 1997 FAD requires NYCDEP to submit a strategy for prioritizing and implementing non-point source programs. The strategy must be consistent with the MOA and include, at a minimum: stormwater controls, stream corridor protection/stabilization, sand & salt storage, forestry and public education. Additionally, the FAD requires NYCDEP to submit a prioritized list of non-point source programs and report quarterly on the status of implementing projects. The FAD also requires that NYCDEP submit a Wetlands Protection Program and that it work with NYSDEC to develop and submit a short- and long-term schedule for the Pesticide and Fertilizer Technical Working Group. The FAD also requires NYCDEP to develop a guidance manual for implementing the stormwater provisions of the Watershed Rules and Regulations, including guidelines for developing pollution prevention plans, individual residential stormwater management plans and plans for wetlands and watercourse crossings, pipings and diversions.

Reports to meet each of the above FAD requirements have been satisfactory and have been submitted in a timely manner. In addition, the City submits an Annual Report (Task 901a) which includes the status of non-point source activities. It should be noted that the Pesticide and Fertilizer Technical Working Group recommendations were submitted to the Watershed Protection and Partnership Council Executive Committee in March 2000.

B. Program Assessment

Several of the FAD and MOA Partnership Programs are directed at controlling non-point pollution and are fully assessed in other chapters in this report. They include:

- Regulatory programs implemented through the Watershed Rules and Regulations. A discussion of NYCDEP activities regarding implementation of the regulations, specifically **Storm Water Pollution Prevention Plans** is included in Chapter XII of this report.

- Three MOA partnership programs are directed towards controlling non-point pollution from septic systems. They are discussed in detail in Chapter VII of this report and include:

  - **Septic Rehabilitation and Replacement Program;**
  - **New Sewage Treatment Infrastructure Program; and**
  - **Sewer Extension Program**

- The **Watershed Agricultural Program** is the primary mechanism for controlling nonpoint sources from agricultural activities and is described in Chapter IV of this report.

- The preservation of high water quality in the Kensico Reservoir is extremely important to the continuation of filtration avoidance. The **Kensico Modeling and Remediation Program** addresses nonpoint sources in the watershed and is discussed in Chapter V.

- Phase I **Total Maximum Daily Loads** (TMDLs) have been developed for the New York City Water Supply. These address both point and nonpoint source loads and are discussed in Chapter XI.

- The **Land Acquisition Program** is critical in preventing the creation of future nonpoint sources of pollution. Chapter III of the report evaluates this program.

- NYCDEP's ability to document the effectiveness of its nonpoint source control programs is closely tied to the **Modeling and Monitoring Programs**. These programs are assessed in Chapters X and XIII.

The following nonpoint source programs are assessed in this Chapter:

- **Stream Management Program (VI.A);**
- **Wetlands Protection Program (VI.B);**
- **Watershed Forestry Program (VI.C);**

- **Sand and Salt Storage Program (VI.D); and**
- **Public Education and Outreach (VI.E).**

In addition to the non-point source control programs assessed in this document, the MOA has provided funding for the implementation of non-point controls. NYCDEP conducts a Stormwater Retrofit Program in the west-of-Hudson watershed. Funds provided through this program are used for the design, construction, implementation and maintenance of stormwater control practices to address existing stormwater runoff (resulting in erosion or pollutant loading) in concentrated areas of impervious surfaces. The east-of-Hudson Water Quality Investment Program allows for funding of a wide range of remedial activities to control pollution from non-point sources such as failing septic systems, stormwater and unstable streambanks. To date, however, Westchester and Putnam Counties have not taken advantage of this opportunity to fund non-point controls. As a result, non-point sources which are addressed through specific programs west-of-Hudson are not being actively addressed in Catskill/Delaware basins located east-of-Hudson.

It should also be noted that Delaware County has developed a Comprehensive Strategy for Phosphorus Reductions in response to the Cannonsville Reservoir's status as a phosphorus-restricted basin. In addition to point sources, the strategy addresses non-point source pollution from septic systems, stormwater, agriculture and forestry.

C. Conclusions/Recommendations

Most non-point source pollution conclusions/recommendations can be found in the individual chapters referenced above. However, there are two overarching recommendations that EPA has included here.

Programs addressing septic system failures, stormwater runoff, streambank erosion and other non-point sources of pollution are being implemented by the City or through City funding in the Catskill/Delaware basins located west-of-Hudson. These types of programs are also eligible for funding under the City-funded ($68 million) east-of-Hudson Water Quality Investment Program to address water quality concerns in the Croton system and in the West Branch and Kensico basins (both east-of-Hudson). However, there is no assurance that this county directed program will address non-point source pollution, let alone non-point source pollution in the Catskill/Delaware basins located east-of-Hudson. **EPA recommends that NYCDEP develop a detailed strategy to address non-point sources of pollution in the Catskill/Delaware basins located east-of-Hudson. EPA recommends that this strategy focus on key non-point sources of pollution such as stormwater runoff, failing septics (also see EPA's recommendations in Chapter VII), and streambank erosion.**

A number of streams within the New York City watershed are classified by NYSDEC as "D." This classification is not consistent with the Clean Water Act (CWA), as it only provides protection for fish survival and not fish propagation. **EPA recommends that NYSDEC either upgrade Class D waters**

in the New York City watershed to use classifications consistent with the CWA or complete use attainability analyses for these waters which demonstrate why these uses are not attainable.

VI.A Stream Management Program

1. Introduction - Program Objectives

Turbidity "events," or periods of elevated turbidity --- often caused by storms, have periodically raised turbidity in the Ashokan reservoir to levels exceeding five nephelometric turbidity units (NTUs), threatening shutdown of the Catskill Aqueduct. The Catskill Aqueduct conveys 40% of the City's water supply. To address these episodic turbidity events, the 1997 FAD (Tasks 308g, h and i) requires that NYCDEP implement a "Stream Corridor Protection/Stabilization Program" (called the "Stream Management Program" in all future references) along stream corridors in the Catskill/Delaware watershed. Turbidity is problematic from a water supply standpoint. Elevated levels may interfere with disinfection (e.g., chlorination) efficiency and may indicate the presence of pathogens and excess nutrients in source water. For these reasons, turbidity is an EPA regulated parameter under the Surface Water Treatment Rule (SWTR) and is a factor in determining the need for filtration. In addition, turbidity signals poor stream health: elevated levels of suspended solids and associated turbidity are often caused by stream channel and bank instability. Therefore, the overall objective of the Stream Management Program is to reduce turbidity along stream corridors, to enhance stream health and ultimately to maximize public health protection. Success of this program will be measured by a reduction in turbidity accompanied by an enhancement in stream health, demonstrated by biomonitoring and turbidity monitoring in affected stream corridors and receiving reservoirs.

2. Background

EPA's first filtration avoidance determination (January 1993) stated that a particular problem in the Catskill watershed is the recurring high turbidity that threatens long-term compliance with the raw water turbidity requirement of the SWTR. To address EPA's concerns and to comply with the January and December 1993 FADs, NYCDEP submitted a *Plan to Reduce Turbidity in Schoharie and Ashokan Reservoirs* (FAD Task 14c - June 1993) and an overall *Stream Corridor Protection Plan* (FAD Task 308c - June 1994). The objective of the *Plan to Reduce Turbidity* was to identify and target turbidity source areas for remediation through the use of "best management practices" (BMPs). BMPs would be evaluated for their effectiveness in both reducing turbidity and mitigating its impacts. The objective of the *Stream Corridor Protection Plan* was much broader - to preserve stream corridors in order to protect the City's water supply through land acquisition, regulatory programs, and partnership programs. One element of the *Stream Corridor Protection Plan*, the "Local Stream Corridor Protection Initiative," focused on gaining community support through a NYCDEP/local partnership approach to protect stream reaches. It was this element of the *Stream Corridor Protection Plan* along with the data and BMP research generated from the *Plan to Reduce Turbidity*, that, in 1997, formed the backbone of the City's Stream Management Program.

3. Stream Management Program Description

Acceptance by and partnership with the communities along the affected streams is key to the long-term success of the Stream Management Program. Community acceptance is especially critical since much of the mitigation efforts would take place on or require access through private land. Thus a major emphasis of the Program is on education and forging partnerships among NYCDEP, west-of-Hudson watershed communities and local agencies. Through this Program, the City plans to address the problems related to stream bed and bank erosion, turbidity, flood damage and habitat destruction and to achieve grass-roots stewardship of the watershed. The City's Stream Management Program includes the following three programmatic elements:

(i) ***Education, Training and Public Outreach*** to assist in the development of an informed constituency of stream managers and to increase landowner participation. The inclusion of stakeholders in the process will enhance consensus building and community buy-in, thereby improving the success rate of the overall Program.

(ii) ***Database Development*** to target remediation efforts and to support the engineering decisions necessary to implement remediation designs. Data will also be used to assess the impacts of turbidity as well as of other stream contaminants on water quality and to assess the effectiveness of the remediation efforts.

(iii) ***Development and Implementation of Stream Management Plans*** in priority sub-basins to establish a network of stream stability restoration demonstration projects. These projects will provide a framework for evaluating the efficacy of stream BMPs using natural geomorphic designs.

The Program Assessment section, below, will provide a detailed evaluation of these three program elements in meeting the overall objective.

4. Program Assessment

A. FAD Task Compliance

In accordance with FAD Task 308g, in September 1997 the City submitted a prioritization strategy and an implementation timetable for non-point source programs, including the Stream Management Program. As obligated under the NYC Watershed Memorandum of Agreement (MOA), in May 1998, NYCDEP submitted a list of prioritized sub-basins in the Catskill/Delaware watershed which would be subject to the development and implementation of Stream Management Plans. In September 1998, in accordance with FAD Task 308h, the City submitted a prioritized list of non-point source programs for

implementation which, again, included a list of prioritized sub-basins and a general timetable for the development of Stream Management Plans. This table (see Table VI.A.1) includes "initiation dates" for the development of the Plans. The City updates EPA on the status of the Stream Management Program through quarterly progress reports (Task 308i) and its annual report (Task 901a). These updates have all been provided to EPA on a timely basis. We also note that, although not a FAD requirement, NYCDEP has submitted updates to Task 308g (*Annual Report on the Strategy for Prioritizing and Implementing Non-point Source Programs*), which also includes the status of the Stream Management Program.

Table VI.A.1 - Stream Management Plan Implementation Schedule

Initiatation Date	Stream Management Plan (Sub-basin)	Watershed Basin
Prior to 1998	Batavia Kill	Schoharie
1998 - 2000	Broadstreet Hollow	Ashokan
	Stony Clove Creek	Ashokan
	W. Branch Delaware River	Cannonsville
	Chestnut Creek	Rondout
	Trout Creek	Cannonsville
2000 - beyond	Esopus Creek	Ashokan
	Woodland Valley Creek	Ashokan
	Schoharie Creek	Schoharie
	East Kill	Schoharie
	West Kill	Schoharie
	Schoharie Headwaters	Schoharie
	Trout Creek	Rondout
	Sugarloaf Brook	Rondout
	Neversink River	Neversink
	W. Branch Neversink River	Neversink
	E. Branch Neversink River	Neversink

	E. Branch Delaware River	Pepacton

The implementation status of the Stream Management Plans (listed above) and associated stream restoration projects will be discussed in more detail in the Program Implementation Section, below.

B. Program Implementation

i. Education, Training and Public Outreach - NYCDEP's activities in this area have been exemplary. The City has conducted numerous workshops, seminars and field trips with county Soil and Water Conservation Districts (SWCD), county public works officials, local planning departments, town highway departments, and other State and local organizations responsible for stream management. These programs provide "state-of-the-science" information on the geomorphic restoration of streams. Over the last several years, workshops taught by NYCDEP staff or a combination of academic consultants and NYCDEP staff have included instruction in the areas of:

- geomorphic stream channel assessment and monitoring,
- bank and channel stability restoration work,
- flood hazard reduction,
- habitat assessment and enhancement,
- stormwater management, and
- riparian buffer design.

Examples of recent education/outreach efforts include: (1) a one-week course, "Applied River Morphology," taught by a renowned expert in stream geomorphology attended by over 40 watershed professionals from many different organizations directly involved in river assessment/remediation; (2) a week-long workshop on the geomorphic restoration process, attended by over 90 people, was sponsored by NYCDEP, co-taught by Greene County SWCD and Clear Creeks Consulting; and (3) a day-long field and classroom training session titled "Habitat Assessment for Restoration and Monitoring" taught by the Cornell Cooperative Extension's Fish and Wildlife Unit. The success of the City's education, training, and outreach efforts is measured by the number of programs and workshops offered, participation level and participant feedback. Based on the outreach efforts to date, the numbers and backgrounds of program attendees and comments received by EPA during this mid-course review, we believe that NYCDEP has successfully implemented this element of its Stream Management Program.

During EPA's mid-course review, community members expressed enthusiasm in the Program goals and an eagerness to apply stream restoration techniques in the field. In fact, a number of individuals expressed frustration in the delays experienced in the City's implementation of the Program (e.g., Broadstreet Hollow - see further discussion on this, below). Many felt the earlier remediation actions

(e.g., rip-rap and trenches), prior to the implementation of the geomorphic approach to stream bank stabilization, were minor, cosmetic short-term fixes that did not fully correct problems. Clearly, community interest is high. In order to maintain that interest, the City must quickly build upon its success and step up the implementation phase of the Program. We are concerned that without a pipeline of active remediation projects, the enthusiasm for this Program will soon turn to skepticism and mistrust within the affected communities, the very barriers that this outreach effort has recently overcome.

ii. Database Development - NYCDEP has devoted considerable effort over the last several years to identifying turbidity source areas and to estimating turbidity loadings from individual reservoir sub-basins (1993 FAD Tasks 14c and 308f). This information was used in developing NYCDEP's *Criteria for Prioritizing Project Selection* (May 1998), which prioritized stream corridors (projects) for remediation in the 80 sub-basins in the Catskill/Delaware watersheds. Other factors included site accessibility, potential for effective implementation of the geomorphic design, land-owner cooperation and local interest. A GIS-based analysis identified 18 priority sub-basins that will be targeted for stream restoration work; information from this effort was incorporated into FAD Task 308g (September 1999). Selection and prioritization of the specific 18 sub-basins (see Table VI.A.1**,** above) was primarily based upon surrogate water quality data from each sub-basin, known flood hazards, and reservoir management options.

NYCDEP continues to make progress in collecting and analyzing the large amounts of stream data necessary for the development of geomorphically-based designs for stream stabilization projects. NYCDEP started a summer internship program to assist in this effort. It has proven to be quite successful. An intergovernmental agreement between Ulster County Community College and SUNY Oneonta to assist in data collection is in its fourth year of implementation. Over an eight to ten week season, field teams collect and assist in the analysis of stream data in order to develop regional hydraulic relationships necessary for the design of geomorphic solutions to stream bank and bed erosion problems. NYCDEP staff continue to review and analyze these data for incorporation into their stream management plans.

iii. Development and Implementation of Stream Management Plans - As stated by NYCDEP, a core objective of the Stream Management Program is the development and implementation of stream management plans to protect and improve the raw water quality in priority Catskill/Delaware sub-basins. While a couple of "stand-alone" demonstration projects have been completed (Brandywine and Maier Farm on the Batavia Kill - see below) and are integral parts of stream management plans, they do not replace the need to develop and implement these plans. We also recognize that the geomorphic assessment and classification phase is very resource- and time-intensive, and that it must be conducted prior to the completion of a stream management plan. However, the plans drive the Stream Management Program forward, and their implementation must be completed before the success of the program can be assessed. We are, therefore, very concerned that no plans have been completed to date. It is our expectation that, prior to the expiration of this FAD, significant progress will be made in

implementing plans for the sub-basins listed in Table VI.A.1.

Stream management plans include the establishment of restoration demonstration projects to illustrate and document the effectiveness of geomorphically-based BMPs. The City has implemented projects on stream reaches with known turbidity and stream bank stabilization problems. (See Table VI.A.2 for the status of all demonstration projects.) To date, one demonstration project has been completed: the **Maier Farm** project in the town of Ashland. Within days of completing the **Brandywine** site, Tropical storm Floyd damaged the newly planted riparian vegetation, since it had not had enough time to take root. Restoration of this vegetation will be implemented by Greene County SWCD during field season 2000. (We note that the **Lexington Bridge** project was completed in 1997 but utilized a hybrid geomorphic design [e.g., W-weir, rock vanes] with the more traditional engineering tools [e.g., rip-rap] to stabilize a small stream reach.) These projects are on the Batavia Kill, the highest-priority stream in terms of sediment load (Task 308f - October 1994), and a major tributary to Schoharie Creek. Completed in 1999 and encompassing 4,900 linear feet of channel, they represent the first time geomorphic principles were exclusively utilized in New York State for stream restoration. As part of NYCDEP's overall strategy to reduce turbidity, the Maier Farm and Brandywine sites serve as an outdoor classroom for local, county and state stream managers in the utilization of geomorphic techniques in the restoration of streams in the watershed. Now that these two projects have been completed, the City should develop a plan to evaluate their effectiveness.

Table VI.A.2 - Status of Demonstration Projects

Project	Sub-basin	Status
Brandywine	Batavia Kill	complete (1999)*
Maier Farm	Batavia Kill	complete (1999)
Red Falls	Batavia Kill	in design
Big Hollow	Batavia Kill	in design
Broadstreet Hollow	Broadstreet Hollow	design complete (1998)
Lanesville	Stony Clove	geomorphic assessment
Skyline Drive	W. Branch Delaware	in design
(not named)	Chestnut Creek	geomorphic assessment
Prattsville**	Schoharie Creek	pre-design

* Damaged by Tropical storm Floyd, to be repaired in summer 2000.

** Project sponsored by Greene County SWCD.

During 1999, NYCDEP was awarded federal funds to implement stream restoration demonstration projects on the **West Branch Delaware River** (Cannonsville Basin), **Stony Clove Creek** (Ashokan Basin) and **Chestnut Creek** (Rondout Basin). With the assistance of grant co-sponsors (Delaware, Greene and Ulster County Soil and Water Conservation Districts [SWCDs] and Cornell Cooperative Extension of Sullivan County), NYCDEP will implement the same natural geomorphic stability principles utilized on the Maier Farm and Brandywine projects on the Batavia Kill. Contracts between NYCDEP and the respective county SWCDs for these three projects are at various stages of development. EPA expects these projects to commence in early- to mid-2000.

Two other projects are planned along the Batavia Kill. During the last quarter of 1999, a geomorphic survey for design purposes was completed by the Greene County SWCD along a one mile stretch of the Batavia Kill's headwaters known as the **Big Hollow**. Final design will be completed in early 2000. Greene County SWCD has been successful in achieving community buy-in for this project as exhibited by the verbal support and approval received from the site landowners. EPA anticipates construction to begin within a year. In addition, Greene County SWCD and NYCDEP are working together to design and construct a channel stability restoration project at **Red Falls** near Prattsville. This site has been identified by NYCDEP as the stream reach contributing the greatest total loading of suspended sediment in the Batavia Kill. EPA anticipates construction to begin in summer 2001.

Downstream of Red Falls, between the Batavia Kill - Schoharie Creek confluence and the Schoharie reservoir, is the **Prattsville** project (on Schoharie Creek). The City has had preliminary discussions with the Town of Prattsville to design and implement a comprehensive geomorphic stability restoration project for nearly three miles of stream channel. This project has entered the pre-planning/pre-design phase.

The stream reach at **Broadstreet Hollow** has been identified by NYCDEP as one of the most significant sources of total suspended solids (TSS) loading for its size, relative to other sub-basins. This project is being conducted by the City in fulfillment of its obligation under a NYSDEC consent order for past wastewater treatment plant violations. The project design and interagency agreements were completed well over a year ago, yet construction has not begun. Unfortunately, this is an example where local enthusiasm was initially very high but is quickly dissipating due to the apparent "bureaucracy" which has completely stalled any progress on the project. The City's effort to register this project with the City's comptroller's office (reported through Task 308i) took approximately one year. This source of turbidity remains unabated.

The **Skyline Drive** project is also being conducted by NYCDEP to satisfy a NYSDEC consent order for past wastewater treatment plant violations. Early into the conceptual design, it became obvious that the restoration which had been proposed would not provide a permanent fix for the reach. As the draft design progressed, the project grew significantly in scope, complexity and expense. During the summer of 1999, NYCDEP, working with the landowner, developed and executed a short term strategy (minor excavations within the stream bed) to relieve pressure on key points along the stream. As part of a

longer term restoration strategy the NYCDEP, and Delaware County agencies have agreed to incorporate this project into a larger restoration project being designed for the West Branch of the Delaware River. Construction of the geomorphic design is planned to begin in 2001.

During the mid-course FAD review, EPA received significant feedback from watershed residents and recreational groups who expressed concern over the excessive turbidity found in the Ashokan and Schoharie Reservoir basins. Although there was early momentum and enthusiasm through the City's strong public outreach program, there is a growing sense of frustration that there will be a lack of "follow-through" in getting restoration projects implemented. These groups expressed strong concern over the damage to the Catskill area caused by storms in the mid-90s and were worried about further damage and future implications. They identified stream bank erosion as a long term problem that is impacting the local economy (fishing, tourism) and causing a major financial burden on the residents (private property loss). Successful implementation of the Stream Management Program can meet the multiple, overlapping objectives of the communities, the City and EPA. As NYCDEP has noted many times in the past, community acceptance is paramount to achieving program success. Based on the above comments, we are concerned that a window of opportunity will be lost if critical demonstration projects and comprehensive Stream Management Plans are not completed expeditiously.

Contributing to the delay in implementation of demonstration projects is the length of time it takes to obtain a construction permit from the Army Corps of Engineers (Corps). The Corps requires individual permits for these projects, and it typically has taken 12 to 15 months to review a NYCDEP permit application. In order to streamline the permit process, the City has requested that the Corps consider developing a general construction permit for implementation of demonstration projects utilizing geomorphically-based designs.

C. Water Quality Improvement

Success of the Stream Management Program will ultimately be measured by improvements in stream water quality over time, as seen through lower turbidity and a healthier biotic community along the affected stream corridor, as well as reduced turbidity in the receiving reservoir. The City's routine comprehensive monitoring program, along with turbidity and macroinvertebrate sampling downstream of remediated stream reaches, will provide the tools to gauge the success of restoration projects. (For a more detailed discussion of the City's routine monitoring program refer to Chapter XIII.) We also expect that site inspection and stream bank soil loss measurements will be an important component of each stream management plan (another reason why development of these plans is important) and will aid in project evaluation.

NYCDEP' Stream Biomonitoring Program is now in its fifth year of implementation. Since the health and diversity of the stream's macroinvertebrate community is directly related to the water quality of the stream, data produced from this Program will prove vital in assessing the impacts of turbidity and the effectiveness of stream restoration projects (as well as other watershed protection and remediation

projects). Stream samples in the Catskill/Delaware watershed are collected annually, in August and September, along the main stems to the Schoharie, Ashokan, Cannonsville, Neversink and Pepacton Reservoirs. A number of sampling points are keyed to restoration projects. A large amount of biological data has and continues to be accumulated. In January 2000, the City released a *Report on Stream Macroinvertebrate Biomonitoring Conducted within the Watersheds of the NYC Water Supply System during 1994-1998*. This is the first evaluation report on this subject since 1995.

Only the Lexington Bridge restoration project (completed in 1997) has been subject to pre- and post-construction biomonitoring and subsequent analysis. Initial results suggest that there has been some improvement in water quality as a result of the stream stabilization effort. As more of the stream restorations projects are implemented, this type of data gathering and analysis effort will be vital and should continue to be expanded to assess the effectiveness of the Program.

D. Conclusions/Recommendations

NYCDEP's Stream Management Program offers an effective strategy for addressing turbidity emanating from damaged stream reaches. Geomorphic restorations over time will improve overall water quality in the affected streams and receiving reservoirs. To date NYCDEP has shown significant progress in implementing the first element (Education, Training and Public Outreach) of its strategy. EPA supports the local partnerships developed by the City and believes these partnerships to be key elements to the success of NYCDEP's strategy to mitigate turbidity in streams. This approach fosters grass-roots stewardship of the watershed and will ultimately improve the success rate of each stream restoration project. **EPA commends NYCDEP in its Education Training and Public Outreach efforts and recommends that these efforts be continued.**

NYCDEP's implementation of the final element of its Stream Management Program (development of stream management plans and implementation of demonstration projects) has experienced significant delays. The overwhelming success of the outreach effort has developed considerable expectation among the Catskill communities that project implementation is imminent. We believe that there is a window of opportunity that must be seized by the City if this Program is to be successful. EPA commends the City's completion of the Maier Farm demonstration project located along the Batavia Kill. This project represents the first successful application of the exclusive use of geomorphic principles in New York State for stream restoration. However, a number of projects seem "stuck" in the pipeline (e.g., Broadstreet Hollow which has been delayed within the City administration for more than a year). Integral to providing an overall context to all of these projects are stream management plans, none of which has been completed. **EPA strongly recommends that NYCDEP expedite completion of Stream Management Plans in priority sub-basins, and expedite completion of demonstration projects at Broadstreet Hollow, Big Hollow, Stony Clove, Red Falls and the West Branch of the Delaware River. EPA also recommends that NYCDEP begin stream management plans in other sub-basins targeted in its Stream Management Program implementation schedule.**

Timely review by the Corps and NYSDEC of NYCDEP's construction permit applications will help speed up implementation of the City's stream restoration efforts. **EPA recommends that the Corps expeditiously review NYCDEP's construction permit applications. EPA also recommends that the Corps consider a general construction permit for implementation of stream demonstration projects utilizing geomorphically-based designs.**

Evaluation and interpretation of biomonitoring data taken along streams near restoration projects is one element of a monitoring program necessary to establish the success of geomorphic BMPs. The biomonitoring report issued by NYCDEP in January 2000 was the first since the biomonitoring effort began (five years ago) and acknowledges work to be done. In addition, pre- and post-remediation turbidity monitoring, keyed to specific restoration projects, is necessary to assess BMP effectiveness and water quality improvement. **EPA recommends that NYCDEP expand its biomonitoring and pre- and post-remediation turbidity monitoring to measure the water quality benefit derived from its Stream Management Program. In addition, EPA recommends that the City evaluate, interpret and present these data on a more frequent basis.**

VI.B Wetlands Protection Program

1. Introduction - Program Description and Objectives

Over the last decade, it has become increasingly apparent that wetlands play a major role in watershed protection. From a drinking water perspective, one of the most important functions of wetlands is their ability to maintain good surface water quality in watercourses and reservoirs and to improve degraded water. Wetlands remove and retain nutrients, process chemicals and reduce sediment loads to receiving waters. In addition, wetlands can buffer the land against erosion - a significant problem, particularly in the Schoharie and Ashokan basins. Of the over 1,010,000 acres in that portion of the New York City watershed west of the Hudson River, approximately 12,000, or a little over 1%, are wetlands. Of the approximately 240,000 acres of watershed land east of the Hudson River (which includes the West Branch, Boyd Corners, and Kensico watersheds), the relative numbers are much greater - over 6% are wetlands. There are approximately 2,000 acres of wetlands in the West Branch/Boyd Corners watershed and 250 acres of wetlands in the Kensico watershed. While wetlands are not a major landscape feature of the New York City watershed, their impact on water quality should not be underestimated. Preventing the further loss or degradation of remaining wetlands is another important consideration of filtration avoidance and the objective of the City's Wetlands Protection Program.

The foundation of the City's Wetlands Protection Program is the Wetlands Protection Strategy, a document which NYCDEP submitted to EPA on December 13, 1996, in accordance with FAD Task

308j. The stated objective of the Strategy was to "develop and implement a wetlands protection program that will preserve the critical water quality protection functions provided by natural wetlands systems located within the Catskill/Delaware water supply system watersheds." It follows that program success is ultimately measured by its effectiveness in preserving wetland systems.

One aspect of NYCDEP's Wetlands Protection Strategy is to focus existing watershed programs (e.g., Land Acquisition Program, Stream Corridor Protection/Management Program, and Agricultural Program) on wetlands protection. Another aspect of the Strategy is to use existing regulatory tools (e.g., New York City Watershed Rules and Regulations, State Environmental Quality Review Act, wetland permits under Articles 15 and 24 of Environmental Conservation Law, and Section 404(b) of the Clean Water Act) to mitigate the potential impact of development on wetlands. Finally, NYCDEP has been conducting wetlands research and mapping to support the protection/mitigation efforts mentioned above. NYCDEP outlines its Wetlands Protection Strategy as follows:

- Wetlands Mapping and Inventory - National Wetlands Inventory Mapping Project

- Non-Regulatory Programs
  - < Acquisition of Wetlands
  - < Planning, Technical Assistance and Education
  - < Stream Management Plans
  - < Agricultural Wetlands
  - < Wetlands Science and Research

- Regulatory Programs
  - < Project Review
  - < DEC Wetlands Map Revision

- Program Re-evaluation

EPA will evaluate the program by reviewing progress in meeting the objectives of each of the Strategy components listed above.

2. Assessment

A. FAD Task Compliance

On December 13, 1996, in accordance with FAD Task 308j, NYCDEP submitted a Wetlands Protection Strategy to EPA. The City reports on the Program's status annually in the *Filtration Avoidance Annual Report* (Task 901a), as required in the FAD. It also reports, on an ad hoc basis,

in the *Quarterly Report on the Status of Implementing Projects Designed to Reduce Non-Point Source Pollution* (Task 308i). The Strategy itself contains no deadlines or milestones; rather it is a roadmap that, if followed, should increase the protection of wetlands in the New York City watershed.

B. Program/Strategy Implementation

i. Non-Regulatory Programs - The City's Wetlands Protection Strategy includes three watershed protection programs: Acquisition of Wetlands, Stream Management, and Agricultural Wetlands. The measure of success of these three programs is whether they contribute to the long-term protection of water quality sensitive wetlands. In addition, the City maintains a Technical Assistance and Education Program to assist local governments and community groups in protecting wetlands.

Acquisition of Wetlands

Acquisition is clearly the most direct method of protecting wetlands. To some extent protection of wetlands is "built in" to the entire Land Acquisition Program through its "natural features criteria." One criterion that makes a parcel eligible for solicitation/acquisition is that it contains "in whole or in part a federal jurisdiction wetland greater than five acres or a New York State Department of Environmental Conservation (NYSDEC) mapped wetland." A parcel is also eligible for solicitation/acquisition if it is within certain limiting distances of watercourses and reservoirs. As wetlands are often found near watercourses, this criterion would qualify a significant amount of wetlands in the New York City watershed. In addition, for areas in watershed basins within 60-day travel time to the City's distribution system, there are no natural features restrictions on land solicitation/acquisition except parcel size, and even that restriction is eliminated in Kensico and West Branch. (We suggest that the reader turn to Chapter III for a more detailed description of the Land Acquisition Program and to Table III.1 for additional information on acquisition eligibility.)

Of the 18,440 acres of watershed land that NYCDEP has acquired, or is under contract to acquire, approximately 659 acres (or 3.6 %) are wetlands. See Table VI.B.1.

Table VI.B.1 - Wetlands Acquisition

	West-of-Hudson	West Branch, Boyd Corners & Kensico
Wetland Acres Acquired	211	448
% of Watershed Land Acquired that are Wetlands	1.6%	8.1%

% of Watershed that are Wetlands	1.2%	7.0%

A yardstick by which to measure program success is a comparison of the percent of watershed land acquired that are wetlands to the percentage of wetlands in the watershed. A greater percentage of wetlands acquisition, as presented in Table VI.B.1, would indicate that wetlands are being targeted for acquisition and that this part of the Wetlands Protection Strategy is working. It is important to note that, in accordance with the FAD and the MOA schedule, most of the solicitation and acquisition to date has been in Priority Areas 1 and 2. In these areas, the City must solicit 95% and 90%, respectively, of eligible land. In other words, through January 2000, the City has had very little flexibility in selecting which land to solicit. Thus, the apparent focus on wetlands acquisition to date may be solely a function of the inherent bias of the Natural Features Criteria towards soliciting parcels that include wetlands rather than any because of any *extra* emphasis on soliciting and acquiring wetlands.

The true test of the wetlands acquisition element of the Strategy will be in Years 4 through 8 of the Land Acquisition Program, when NYCDEP will have much more discretion in choosing land to solicit. In Years 4 through 8, it will solicit 75% and 50% of eligible land in Priority Areas 3 and 4, respectively. Because the City will not have to solicit all eligible land, it will have an opportunity to focus on specific water quality concerns. Consistent with the Wetlands Protection Strategy, focusing on wetlands solicitation and acquisition should clearly be a priority. It is EPA's expectation that the City will protect as many high-value wetlands as it can through acquisition. Therefore, we anticipate that the acreage of wetlands acquired as a percentage of all watershed land acquired will continue to rise as the Land Acquisition Program moves forward.

We note that success of the Program is not measured just by the number of wetland acres acquired, but by the type and function of the wetlands acquired and the assurance that the integrity of the wetlands ecosystem is being preserved. For example, the City might purchase a parcel that includes wetlands that are part of a larger wetlands ecosystem not under the City's control. If a water quality function of the wetlands ecosystem deteriorates, due to development or other external factors, the function of the wetlands the City purchased will be reduced. As a result, the City's acquisition would potentially lose value in maintaining/enhancing water quality. The City should attempt to "piece together" purchases to enhance the long-term viability of wetland ecosystems.

To date, a number of large land purchases in the West Branch/Boyd Corners watershed include expansive areas of wetlands. Clearly these purchases will go a long way toward protecting large wetland ecosystems. EPA encourages the City to highlight acquisitions that are particularly beneficial to the Wetlands Protection Program in its quarterly report and to update the amount of wetlands acreage purchased per basin. EPA also notes that, in those instances in which NYCDEP acquires impaired wetlands and/or buffers, it has the opportunity to repair or enhance their function and value. Based on information provided to date, EPA does not believe that the City has purchased any wetlands for this

purpose.

Stream Management Program

Another component of the City's Strategy is to utilize the Stream Management Program to protect wetlands along stream corridors. An objective of this program is to protect existing wetlands or restore or create new wetlands to stabilize stream banks against erosion. Thus the Stream Management Program and the Wetlands Protection Program have overlapping objectives and are meant to compliment each other. To date two restoration projects in the Stream Management Program have included riparian buffer enhancement and/or restoration: the Maier Farm and Brandywine sites, both of which are along the Batavia Kill in the Schoharie basin. (A riparian buffer is an area of vegetation adjacent to streams, lakes or wetlands.) Together, these two projects affect a stream length of over 4,900 feet. Unfortunately, the riparian buffer planted at the Brandywine site had very little chance to take root before it was destroyed by tropical storm Floyd in September 1999. The City must make implementation of streambank stabilization projects (with riparian buffer improvements) a high priority if the Stream Management Program is to be an effective component of the Wetlands Protection Strategy. (A full assessment of the Stream Management Program can be found in Chapter VI, Section A.)

Agricultural Wetlands

Wetlands protection is an integral part of the City's Watershed Agricultural Program. (A full assessment of the Watershed Agricultural Program can be found in Chapter IV.) As part of the program, Whole Farm Plans are developed for each farm, during which hydrologically sensitive areas (e.g., wetlands) and high-pollutant loading areas are delineated. If the planning process shows that a high-pollutant loading area lies within a hydrologically sensitive area, this portion of the farm is considered a "critical management zone" for protecting water quality. This zone is then prioritized for mitigation using site- or problem-specific "best management practices" or BMPs. Because whole farm planning is a "holistic" process, assessing the wetlands protection component is best discussed in the context of the overall Watershed Agricultural Program (see Chapter IV). If it is progressing well (and Chapter IV does give it a positive assessment), it stands to reason that the Watershed Agricultural Program is a valuable element of the Wetlands Protection Program.

The Conservation Reserve Enhancement Program (CREP), a partnership program funded by the U.S. Department of Agriculture to address specific water quality concerns related to agricultural use, is an initiative being carried out through the Watershed Agricultural Program. CREP uses financial incentives to encourage farmers to enroll in contracts of 10 to 15 years in duration to remove land from agricultural production. One of the goals of the program is to target the enrollment of 2,000 acres of riparian buffer lands in five years, which would result in the protection of approximately 165 stream-miles in the Catskill/Delaware watershed. In 1999, contracts were developed with a total of 42 acres of riparian buffers. It is anticipated that 400 acres (approximately 60 miles) of riparian buffers will be developed during 2000. The active management of these buffers is an important component of this

protection program. For example, the contracts will require the implementation of fencing (to keep cattle out of the buffer), alternative water sources for farm animals, and tree/shrub planting. Looking forward, we do not have information on how much of the riparian buffer acreage under contract is actually wetlands. This would be useful information for tracking the progress of this element of the Wetlands Protection Program. Overall, this is a very impressive program which, once fully implemented, will be a key element to the City's strategy for protecting wetlands.

Technical Assistance and Education

NYCDEP has sponsored or participated in several workshops and educational outings over the last two years, all geared toward encouraging local interest in wetlands protection. These events have taken place in Westchester, Dutchess, Sullivan, Ulster and Delaware Counties. Future programs are planned for Putnam and Greene/Schoharie Counties. The Nature Conservancy's Great Swamp program and its resulting management plan (in which NYCDEP has been a participant) is an excellent example of how strong community interest can propel wetlands protection efforts. While we applaud the City's outreach efforts to date, it would be a true sign of success if the kind of local interest and resolve seen in the Great Swamp can be generated for sensitive areas in the Catskill/Delaware system.

ii. Regulatory Programs - The City reviews projects that may impact wetlands through three main regulatory programs: State Environmental Quality Review Act (SEQRA), the City's Watershed Rules and Regulations (WR&R), and wetland permits under Articles 15 and 24 of Environmental Conservation Law and under Section 404(b) of the Clean Water Act. Mitigating against wetland impacts is just one element of an environmental review of projects under SEQRA. For a more expansive assessment of the City's role in reviewing projects under SEQRA (and the WR&R) see Chapter XII. An assessment of the use of the WR&R as a tool in protecting wetlands follows.

Watershed Rules and Regulations

Only an area that is at least 12.4 acres in size and has been mapped as a wetland by New York State Department of Environmental Conservation, pursuant to Environmental Conservation Law, is defined as a wetland under the WR&R. As estimated by NYCDEP, this translates into approximately 25% of wetlands in Kensico, West Branch and Boyd Corners and more than half of the wetlands in the west-of-Hudson basins not being afforded specific wetlands protection under the WR&R. However, in that many small wetlands are along watercourses, they may be afforded protection as a watercourse under the WR&R. Additionally, a wetland of any size can be defined as a wetland under the WR&R if it has been designated by New York State as having unusual local importance. No wetlands have been designated as such to date. Thus, a significant number of wetlands in the watershed are not subject to protection under the WR&R.

For those wetlands that fall under the WR&R definition, the main protection provided is that of a

setback or "limiting" distance requirement between the wetlands and certain activities or projects. However, there are numerous exemptions to this setback requirement based on project type and location in the watershed. To mitigate the potential environmental harm of the exemption, subject projects are required to develop and implement a Stormwater Pollution and Prevention Plan (SPPP). (These plans are also required for a variety of land disturbance activities, regardless of location - see the WR&R for specific requirements.) Their objective is to minimize the pollutant load generated from the project area into receiving streams or wetlands. While this is a positive mitigating feature, the plan's objective does not include ensuring that the functions and values of the surrounding wetlands are maintained. In other words, there may be a very good SPPP in place (and the City has been aggressive in developing strong SPPPs), but the lack of an upland buffer or a change in the flow direction and velocity of storm runoff may ultimately destroy the long-term integrity of the wetlands. In addition, it is important to note that the City, through its WR&R, has no authority over a landowner's decision to actually fill wetlands. That decision is subject to federal and state permitting authorities, which rest with U.S. Army Corps of Engineers and NYSDEC. In summary, EPA believes that, while the WR&R can mitigate a project's impact on wetlands, it is not one of the strongest components in the City's wetlands protection strategy.

U.S. Army Corps of Engineers Wetlands Regulations

Section 404 of the Clean Water Act provides the U.S. Army Corps of Engineers (the Corps) primary authority over federal permits to discharge fill into wetlands. The implementation of these regulations, therefore, has a direct impact on the long-term protection of wetlands. Although the City has no regulatory authority in this program, for several years the Corps has forwarded to NYCDEP copies of applications for Individual Permits and Pre-construction Notifications (PCNs) for activities covered under the Corps' Nationwide Permit Program (NWP), concerning projects in the watershed. The City's strong involvement in this process is important and we support statements made in a March 15, 1999 letter from NYCDEP asking the Corps to formalize and strengthen that involvement. The City has the expertise and the resources to review and make recommendations to the Corps on the water quality impact of all wetland fill projects that require permits (individual permit or NWP) in the watershed. Those resources should be utilized.

We note that on July 1, 1998, the Corps provided Public Notice in the Federal Register of significant changes to its Nationwide Permit Program. This revised Program, as it was proposed, would have allowed large amounts of wetlands acreage that were previously subject to individual permits to be opened up to NWPs. However, to balance this change, the Corps highlighted the need to impose regional conditions to limit the applicability of NWPs to ensure that no more than minimal adverse effects occur in each Corps District. Consistent with this approach, on November 18, 1998, the New York District of the Corps proposed a specific regional condition for the New York City watershed. Throughout the fall of 1998, the City supported this proposal and, in fact, suggested an even stronger regional condition for the watershed. This support was documented in the City's quarterly FAD submittal (308i - January, 1999).

The City's advocacy for stronger regulatory measures to protect wetlands is entirely consistent with its role as watershed steward. However, in February and March, 1999, in the face of significant opposition from upstate communities, the City completely withdrew its support for any regional condition for the New York City watershed. EPA understands the concerns that have been expressed by upstate communities. However, EPA believes that these concerns were overstated and that the City reacted hastily in its rescindment of its previous arguments for stronger regulations. By no longer being an advocate for a regional condition, the City was accepting less regulatory protection for wetlands in the New York City watershed.

After much public feedback nationally, in March 2000, the Corps announced a new NWP program that is significantly more protective than the existing program as well as the 1998 proposed replacement program. The acreage cap has been reduced from three acres to ½ acre and the PCN threshold has been reduced from 1/3 acre to 1/10 acre. With the additional floodplains restriction below headwaters, this new NWP program is comparable to the regional condition that the Corps originally proposed for the New York City watershed in October 1998 (1/3 acre cap on NWPs). Based on these new, positive changes in the NWP program, EPA does not believe that a lower acreage cap is necessary, watershed-wide. However, as an additional layer of wetlands protection, we recommend that NYCDEP support a regional condition which specifies that the Corps submits all PCNs in the New York City watershed to EPA, NYSDEC and NYCDEP for review and comment. In addition, in light of development pressures
east-of-Hudson and in consideration of West Branch and Kensico Reservoir's extreme importance to the Catskill/Delaware system, EPA is recommending to the Corps that it add a regional condition prohibiting the use of Nationwide Permit 39 in the watersheds east-of-Hudson.

iii. Science and Research - In 1997, the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI), in conjunction with NYCDEP, completed a critical wetlands survey of the New York City watershed which will aid in a number of wetlands protection efforts. From a regulatory standpoint, the information from this survey has identified approximately 1,000 acres of wetlands which meet the NYSDEC criteria for wetland designation but have not been mapped by the State. In 1998, EPA provided NYSDEC funds (through the Safe Drinking Water Act Grant) to field verify and add these wetlands to NYSDEC maps. We expect this process to be complete by the end of 2000. Subsequent to a public hearing and comment period, these wetlands will be afforded additional protections through Section 24 of the State's Environmental Conservation Law and the City's Watershed Rules and Regulations.

The NWI project also provided a foundation for two other significant wetland research projects that were completed in late 1999: *Wetland Trends in the Croton Watershed, New York: 1960's to 1990's* and *Wetland Characterization and Preliminary Assessment of Wetland Functions for the Boyd Corners and West Branch Sub-basins of the Croton Watershed*. We commend the City for spearheading these two efforts; the findings will be useful as the City focuses its wetlands protection efforts in the future. The *Characterization* report is a preliminary strategy for assessing wetlands

functions. This information is particularly timely in the context of the ongoing discussions on the Corps' Nationwide Permit Program in the watershed. Additionally, the City should use this information to work with the State and interested communities to delineate wetlands less than 12.4 acres that are of unusual local importance, to provide them the additional protection of State and City regulatory programs. We strongly encourage the City to continue this program in the West Branch/Boyd Corners basins and throughout the watershed. (We note that NYCDEP has begun to verify and quantify wetland functions in the West Branch/Boyd Corners basin with partial funding by EPA.) The decrease in wetland loss over time documented in the *Wetlands Trends* report is certainly good news. The City should continue this type of analysis as part of a long-term assessment of its Wetlands Protection Strategy.

C. Maintenance of Water Quality

As with other watershed protection oriented programs (e.g., land acquisition), an overarching objective of the Wetlands Protection Program is to maintain high water quality in the Catskill/Delaware system. Wetlands' vital role in watershed protection has become clearer during the past decade. Therefore, a measure of success, in addition to no further wetland loss, will be confirmation, through system-wide water quality monitoring, that this water quality objective is being met. For a more detailed discussion of the City's routine monitoring program and its use in monitoring protection programs, refer to Chapter XIII. EPA notes that there may be instances when wetlands acquisition or wetlands enhancements may be part of a specific remediation program (e.g., through the farm Conservation Reserve Enhancement Program or the Stream Management Program). In these types of circumstances, the City should consider project-specific monitoring to gauge success.

3. Conclusions/Recommendations

The stated goal of the City's wetlands protection strategy is to "protect wetlands in the watershed." Recognizing the importance of wetlands, the federal Clean Water Action Plan sets a goal of reversing the trend of wetlands loss nationwide with a net increase of 100,000 acres each year, beginning in 2005. **Consistent with the Clean Water Action Plan, and considering the vital role wetlands play in the New York City watershed, EPA recommends that the City set a goal of increasing wetlands acreage in the watershed.**

Success of the City's wetlands protection strategy is measured through monitoring the change in wetlands acreage and functions over time. Currently the strategy contains no methodology to measure program success. The 1997 National Wetlands Inventory and recent studies on wetlands trends and characteristics in the Croton watershed (1999) is a step in the right direction. **EPA recommends that the City develop an objective measure of progress for its Wetlands Protection Program. The wetlands trend and functions analysis performed in the Croton watershed should be expanded and carried over to the entire watershed. In addition, the City should work with the Corps**

and NYSDEC to ensure that wetlands losses/gains are well documented so that it can analyze future wetlands trends.

Land acquisition is a cornerstone to the City's wetlands protection strategy. As detailed in its Land Acquisition Program, in the coming years the City will have increased flexibility in choosing which land to solicit to meet FAD-mandated solicitation goals. **With this greater acquisition flexibility, EPA recommends that the City strategically piece together parcels of high-value wetlands to maintain the long-term viability of wetlands ecosystems.**

The objectives of the City's Stream Management Program include mitigatation and enhancement of riparian buffers (including wetlands) and stabilization of stream corridors. This program, used along with focused acquisition, has the potential to provide long-term protection and improvements to wetlands along stream corridors. Although there has been significant outreach and planning to date, implementation has been slow. **EPA recommends that the City speed implementation of its Stream Management Program if it is to be an effective component of the Wetlands Protection Program.**

EPA recommends that the City continue its research on delineating high-value wetlands in the watershed. This science-based information will allow NYCDEP to target acquisitions and to prioritize wetlands under 12.4 acres "of unusual local importance" that deserve State and City regulatory protection. **EPA recommends that the State and the City work with communities to reclassify those areas of "unusual local importance" as State wetlands.**

In March 2000, the Corps announced a new NWP program that is significantly more protective than the existing program as well as the 1998 proposed replacement program. With the new acreage cap reduction, PCN threshold reduction and additional floodplains restrictions, this new NWP program is comparable to the regional condition that the Corps originally proposed for the New York City watershed in October 1998 (1/3 acre cap on NWPs). **As an additional layer of wetlands protection, EPA supports, and recommends that NYCDEP and upstate communities support, a regional condition which specifies that the Corps submits *all* PCNs in the New York City watershed to EPA, NYSDEC and NYCDEP for review and comment. EPA recommends that the City review all PCNs to mitigate wetland losses and to recommend to the Corps that all proposed fill projects that may negatively impact water quality go through the Individual Permit process.** In addition, in light of development pressures east-of-Hudson and in consideration of West Branch and Kensico Reservoir's extreme importance to the Catskill/Delaware system, EPA is recommending to the Corps that it add a regional condition prohibiting the use of Nationwide Permit 39 in the watersheds
east-of-Hudson.

The success of the City's Wetlands Protection Program will be measured by the effective implementation of its Strategy, which was submitted to EPA on December 13, 1996, in accordance

with the FAD. The Strategy includes a "program re-evaluation" element. We look forward to participating in the City's re-evaluation prior to the expiration of this five-year FAD and anticipate that the above assessment will be useful in that effort.

VI.C Watershed Forestry Program

1. Objective

The objective of the Watershed Forestry Program is to prevent non-point pollution during timber harvesting operations through the use of best management practices and to maintain large tracts of undeveloped forest as a preferred land use.

2. Background

In 1994, the watershed forestry community organized a task force comprised of landowners, timber harvesters, local and state representatives from the forest products industry, regulatory agencies and environmental organizations. In December 1996, the task force released its policy recommendations, in the *Green Book*. The *Green Book* stated the task force's position that although forestry activities produce a negligible amount of non-point source pollution, increased use of best management practices will further reduce the sediment and nutrient loads from these activities.

The Watershed Forestry Program received $500,000 in funding as a result of the Watershed MOA. The program is administered by the Watershed Agricultural Council (WAC), since approximately 36% of farms in the Watershed Agricultural Program (WAP) are forested (1997 WAP Evaluation).

3. Program Assessment

A. FAD Compliance

The FAD requires NYCDEP to submit a strategy for prioritizing and implementing non-point source programs, a prioritized list of non-point source programs and report annually on the status of implementing projects designed to reduce non-point source pollution. (Tasks 308 g, h & i). Each of these tasks specifically includes the Watershed Forestry Program. EPA has received adequate and timely submittals for each of these FAD Tasks.

B. Implementation

The Watershed Forestry Program has been well received in the watershed, with over 100 applications for cost sharing assistance to develop long-term written forest management plans. As of December 1999, 81 management plans have been completed, representing over 24,700 acres. Management plans must be developed by foresters who have received training in management practices appropriate to meet water quality needs in the watershed. A total of 34 foresters have been trained through this

program.

Cost sharing and incentive programs to promote the use of best management practices are in place. Portable bridges, geotextile fabrics, culverts and road planning are some of the management practices promoted. The Watershed Forestry Program has developed one-page fact sheets suggesting the use of these and other management practices in the watershed. The program also provides cost sharing for loggers to receive training and has approved a "watershed qualified" training program. Approximately 100 loggers have received this training and are recommended through the Forestry Program to farmers and landowners in the watershed.

Education is a strong component of the Watershed Forestry Program. NYCDEP has developed a *Manual for Timber Harvesting on DEP Conservation Easement Lands,* which is distributed through tha Land Acquisition and Stewardship Program. New York State Department of Environmental Conservation, with assistance from the Watershed Forestry Program staff has developed the *NYS Forestry Best Management Practices for Water Quality - BMP Field Guide*. Both of these publications are distributed through the Watershed Forestry Program.

The Program supports research and demonstration projects. The Model Forest Program provides outreach and education to loggers and landowners on long-term forest management and planning. The model forest demonstration projects, which are currently being developed, will provide information for establishing a scientific basis for proper use and management of watershed forests and for evaluating the effectiveness of various management practices. Four sites have been selected to serve as model forests. In addition to the model forest sites, the Watershed Forestry Program funded a study through SUNY-ESF that assessed logger compliance and management practice effectiveness at 60 sites throughout the watershed.

4. Conclusions/Recommendations

The NYCDEP- and WAC-sponsored Watershed Forestry Program assists in reducing the potential for non-point source pollution from forestry activities by promoting best management practices in the watershed. It also provides a number of education and outreach programs for landowners and foresters promoting well-managed forest lands as a preferred land use in a water supply watershed. We note that the Watershed Forestry Program received an EPA Region 2 Environmental Quality Award in 1999.

EPA recommends that NYCDEP continue to support the efforts of the forestry community to promote voluntary best management practices on privately owned lands. These efforts include making low-cost, best management practices available to foresters, training programs and demonstration projects.

VI.D Sand and Salt Storage Program

1. Introduction - Program Objectives

The Sand and Salt Storage Program is a program to upgrade or replace municipal sand and salt storage facilities in the west-of-Hudson watershed. These facilities are used to store winter de-icing materials. The program is managed by the Catskill Watershed Corporation (CWC), in consultation with the City, which has provided $10.25 million in funding. The objectives of this program are to (1) protect water quality from the pollutants often associated with these facilities, namely suspended solids (turbidity) and chlorides and (2) ensure compliance with the City's Watershed Rules and Regulations.

2. Program Assessment

A. FAD Task Compliance

In accordance with FAD Tasks 308g, h, and i, the City reports quarterly on the status of the Sand and Salt Storage Program, which is one component of its overall program to control non-point source pollution in the watershed. The information provided in the quarterly reports is comprehensive and provides sufficient documentation to monitor program progress.

B. Implementation Assessment

In 1998, the CWC, in consultation with NYCDEP, developed program rules which included standards, milestones and a prioritization scheme for constructing sand and salt storage facilities. The Program has been divided into 2 phases. The first phase includes all 30 storage facilities within the Catskill/Delaware (west-of-Hudson) watershed. The second phase includes facilities outside the watershed but which serve at least five miles of watershed roads. The CWC has entered into contracts with local municipalities for the design and construction of all 30 facilities located in the watershed (phase I). By the end of 1999, 17 of these facilities had been completed and three were under construction. Both the City and the CWC estimate that the remaining facilities in the watershed will be completed by the end of 2000. Based on information presented to date, it appears that this program is being implemented successfully.

C. Water Quality Assessment

It is anticipated that installation of state-of-the-art sand and salt storage facilities, including appropriate stormwater controls, will provide significant improvement over existing on-site management of chlorides. These new facilities and controls will reduce the potential for runoff into surface waters. It will be difficult to measure specific water quality benefits from this program given that much of the runoff

problem comes from roadways subject to winter sand/salt application. However, completion of this Program coupled with continued judicious application of winter maintenance materials (in accordance with Section 18-45 of the Watershed Rules and Regulations) will minimize the impacts of sand and salt to the watershed. The City's
watershed-wide monitoring program (see Chapter XIII), which includes monitoring for chlorides and suspended solids, will be the ultimate gauge of program success. (Also, see Chapter XII, for further comment on the use of winter maintenance materials.)

VI.E Public Outreach and Education

1. Objectives and Program Description

In order for the City's watershed protection program to be successful, it must be understood, accepted and ultimately embraced by those who live in the watershed "upstate" and those who drink its water "downstate," as both are stakeholders. There will always be conflicts (economic, social, and environmental), but a strong base of knowledge of watershed issues and increased environmental awareness among all stakeholders will facilitate conflict resolution and enhance the chances of program success. The objective of the City's Outreach and Education Program is to assist and advance watershed protection through substantial stakeholder involvement.

NYCDEP has initiated several outreach/education efforts to meet the above Program objective. A number are geared to specific watershed protection initiatives (e.g., waterborne disease surveillance, forestry, agriculture, land acquisition/stewardship, and stream management/restoration programs, and wastewater treatment plant technical outreach) or to a specific geographic area (e.g., Kensico Reservoir - Kensico Environmental Enhancement Program [KEEP]). These programs are all addressed in more detail in their respective sections of this report. Initiatives discussed below include the MOA west-of-Hudson Public Education Program, NYCDEP's website, watershed signs and general outreach.

2. Assessment

A. FAD Task Compliance

In accordance with FAD Task 308g, h and i, the City reports quarterly on the status of its public education efforts, an integral component of its overall program to control non-point source pollution in the watershed. The reports cover such programs as the MOA Public Education Program, the Kensico Environmental Enhancement Program, forestry and stream management outreach/education and participation on non-point source coordinating committees (state and county). The information provided is sufficient to monitor program progress. There are no deadlines or timetables for any of the education or outreach programs.

B. Implementation Assessment

i. MOA Public Education Program - In 1997, the Catskill Watershed Corporation (CWC), in consultation with NYCDEP, developed rules for a Public Education Program. The $2-million program is funded by the City under Paragraph 131 of the MOA and contains two major elements: (1) public education grants to upstate and downstate schools and non-profit organizations to facilitate education

about the New York City watershed and (2) a Catskill Regional Watershed Museum to "increase public awareness of the human and natural history of the watershed and development of New York City's water supply system." The status of these two program elements is described below.

> **Public education grants** - The CWC established a Public Education Advisory Group in 1997 to help oversee the program. To date two rounds of grants to schools and non-profit educational organizations have been completed. The first round, completed in fall 1998 and funded at $100,000, included 13 projects. Round 2, completed in fall 1999 and funded at $200,000, included 35 projects. Grants have been awarded to educational institutions in Greene, Schoharie, Ulster, Delaware and Sullivan Counties and in New York City. Funded projects include theater workshops, nature trail development, environmental study kits, oral history interviews, and educational curricula, just to highlight a few. Round 3 of the Program, funded at $200,000, began in November 1999 when a Request for Grant Proposals was advertised. Grants are expected to be awarded in summer 2000.
>
> **Catskill Regional Watershed Museum** - In fall 1998, the CWC adopted a resolution to support the development of a watershed museum in the town of Shandaken. Through the MOA, the City has allocated up to half of the $2 million-MOA education fund to establish and maintain the regional museum. By fall 1999, a conceptual plan was developed which summarized the anticipated themes of the museum. Detailed museum plans, as well as a not-for-profit corporation to operate and maintain the future museum, are being formed.

EPA supports these two important educational efforts and finds them to be consistent with program objectives. Based on information provided by NYCDEP, it appears that the CWC's Education Committee is seeking ways to measure the impact and success of the education grants program in order to sharpen their focus. The committee is also exploring additional funding opportunities to extend the life of the program. Clearly, an iterative, ongoing evaluation will enhance program success. EPA commends CWC and the City for the professionalism imparted on the MOA educational effort. In addition, EPA commends the CWC for performing a number of outreach efforts through 1999 such as school visits, town hall meetings, etc.

ii. Webpage Development - Internet outreach is an important public education/interaction tool. The City's webpage has been significantly enhanced over the last couple of years. In particular, EPA notes the City's annual online publication of its Waterborne Disease Risk Assessment Report, a weekly update of *giardia* and *cryptosporidium* (oo)cyst sampling results at City water supply downtakes, and periodic status reports on watershed protection programs. The internet and NYCDEP's webpage present excellent opportunities for the City to substantially increase the amount of user-friendly information it provides on the watershed, such as (1) status reports on its watershed protection programs, (2) relevant meetings, and (3) water quality monitoring data. We fully support the City's

ongoing enhancement of this information resource.

iii. Watershed Signs - A fundamental educational element to watershed protection is alerting travelers that they are in a sensitive area - namely the New York City watershed. When watershed signs were first installed, in early 1999, a number of watershed residents felt that the sign text was hostile in tone and implied that residents should be turning one another in to NYCDEP for polluting. The signs were taken down to modify the message in an effort to garner public support rather than resentment. Although it has taken some time, by early 2000, county, state and NYCDEP officials agreed on new signage and have resolved cost issues. The signs should be in place in spring 2000.

iv. General Outreach - While education is a strong component to a number of City watershed protection programs (see separate sections on stream management, forestry, etc.), NYCDEP should improve its general outreach efforts in the watershed. Feedback that EPA received as part of this mid-course review suggests that watershed communities desire better communications with the City. A number of upstate residents felt that their only contact with NYCDEP occurred when contentious issues developed. These residents are seeking a partnership with the City, rather than an antagonistic relationship, which many currently perceive.

Based on information provided to EPA, the City is not performing any targeted geographic public education/outreach besides its effort through KEEP in the Kensico watershed. In the Catskill/Delaware system, there are a number of lakes and ponds, particularly in Putnam and Westchester Counties, that are surrounded by relatively high-density communities (e.g., China Pond). Some of these communities are organized as Lake Associations. These already existing associations afford the City efficient education and outreach opportunities. By partnering with these groups, the City could tailor presentations, brochures, etc. on watershed issues that may be of particular concern in that area (e.g., septic systems, waterfowl, street cleaning, pesticide usage, garbage disposal, etc.).

3. Conclusions/Recommendations

We commend the Catskill Watershed Corporation and NYCDEP on their implementation to date of the Public Education Program pursuant to Paragraph 131 of the MOA. The City (as well as CWC and the Watershed Agricultural Council) has developed an informative webpage that is a useful tool for disseminating watershed information. We highlighted some of the recent enhancements, above. **Looking forward, EPA recommends that the City substantially increase the amount of user-friendly information it provides on its webpage such as (1) status reports on its watershed protection programs, (2) notices of upcoming meetings, (3) and water quality monitoring results/reports. Ultimately, public access to NYCDEP's GIS data layers would help expand the knowledge base on watershed issues among stakeholders.**

Feedback to EPA during the mid-course FAD review suggested that the City could improve its

relationships with upstate communities by providing more avenues for public input. **EPA recommends that NYCDEP continue to strengthen communication with watershed communities.** It is helpful if the City hears about issues before they become full-blown, intractable problems forcing residents to take sides. **EPA recommends that the City utilize stakeholder involvement tools such as watershed workshops, periodic town meetings, citizen advisory committees, newsletters and even public opinion surveys to facilitate this effort.**

Although laudable, the City's education efforts are generally geared to specific watershed programs. The only geographic-focused outreach effort EPA is aware of is the "KEEP" program at Kensico. High-density lakeside communities, particularly east-of-Hudson, are often potential sources of contamination. However, because some of them have quasi-governmental structures, they also afford efficient outreach opportunities. **EPA recommends that the City forge partnerships with east-of-Hudson Lake Associations and/or organized lakeside groups to (1) educate communities on general watershed stewardship issues and (2) address problems (e.g., septics, pesticide usage, street cleaning and road runoff, etc.) specific to particular lake communities. Targeting these high-density communities is an ideal way to involve, educate and get feedback from watershed stakeholders.**

VII. Septic System Program

1. Objectives

The overall objective of the Septic System Program is to identify and remediate septic systems throughout the New York City watershed which are failing or likely to fail and have a high potential to contaminate the City=s drinking water supply due to geological and hydrological proximity to source waters. The goal of the 1997 Filtration Avoidance Determination (FAD) is to eliminate the threat of non-point pollution sources from septic systems through repair, replacement, or connection to a municipal sewer collection system where available. The City has developed three programs, through the Watershed MOA, to achieve this goal: (1) the Septic System Rehabilitation and Replacement Program, (2) the New Sewage Treatment Infrastructure Program, and (3) the Sewer Extension Program. The success of the overall Septic System Program is dependent on adequate implementation of the these three programs.

2. Background

According to the New York State Department of Environmental Conservation=s (NYSDEC) 1998 Water Quality Report, failing on-site disposal systems are a primary cause of water quality impairment in rivers, lakes and reservoirs in New York State. Failing septic systems in the New York City watershed are non-point sources of pathogens (e.g., *Giardia* and *Cyrptosporidium* (oo)cysts), viruses, and nutrients to groundwater that may impact surface water. It is believed that contamination of surface water may, in part, be attributable to intrusion of contaminated groundwater and/or surface overland flow containing inadequately treated sewage discharged from failing systems.

Control of such discharges has been historically weak due to difficulties in detecting septic system failures. To address this concern, EPA=s FADs have required NYCDEP to develop and implement a methodology to identify and address failing septic systems in the watershed. In response, NYCDEP has investigated several approaches such as infrared aerial surveys,
house-to-house surveys, field inspections and enforcement of established regulations, in an attempt to establish an effective methodology. In June 1994, NYCDEP developed a plan to detect and remediate failing septic systems (deliverable 310e) which included inspections, response to complaints, and stream monitoring. The plan became the City=s Abaseline@ program to address septic systems in the watershed. (In December 1994, NYCDEP conducted a pilot infrared aerial survey to detect possible subsurface septic system failures in the Kensico watershed. By early 1996, the NYCDEP concluded that infrared is not a desirable or reliable method for detecting septic failures based on local community opposition to fly-overs, high cost factors, and false-positive data that were generated.)

Despite the efforts described above, the City detected a very limited number of failing septic systems. This lead EPA to question the adequacy of the program. It was uncertain whether there were actually very few failing septic systems in the watershed, or whether the program, itself, was deficient in its ability to detect failing septic systems. Table VII.1 summarizes NYCDEP enforcement activities that addressed failed septic systems (from 310c/501b FAD reports submitted from January 1994 - December 1996) prior to the signing of the Watershed MOA in January 1997.

Table VII.1 Number of Septic System Failures Detected/Remediated by NYCDEP Prior to the 1/97 Watershed MOA

Year	Kensico Watershed Basin	West Branch/ Boyd=s Corner Watershed Basin	Delaware Watershed Basin	Catskill Watershed Basin
1994	4 detected 3 remediated	2 detected 2 remediated	53 detected 39 remediated	18 detected 9 remediated
1995	0 detected 0 remediated	0 detected 0 remediated	27 detected 33 remediated	11 detected 13 remediated
1996	4 detected 3 remediated	2 detected 2 remediated	21 detected 22 remediated	20 detected 20 remediated
Pre-MOA Total (1994-1996)	8 detected 6 remediated	4 detected 4 remediated	101 detected 94 remediated	49 detected 42 remediated

In December 1996, in accordance with deliverable 310e-1, NYCDEP revised its "Methodology for Prioritizing Routine Inspections to Detect Septic System Failures" to be consistent with the Watershed MOA. The methodology document outlines NYCDEP=s approach to meeting the objectives of the FAD=s Septic System Program. The baseline program activities of inspection patrols, soil tests, stream monitoring, septic system design and construction review/approval, and complaint responses, were enhanced by implementation of the Septic Rehabilitation and Replacement Program and the New Sewage Treatment Infrastructure Program. These enhancements, along with the new Sewer Extension Program, are being implemented by the City in accordance with the Watershed MOA. Their implementation, if successful, is expected to contribute to the City=s meeting the objectives of the Septic System Program. However, as discussed in the Assessment Section, these programs are limited in resources (and are therefore limited in time and scope). Thus, the City=s methodology for detecting failing septics will need to be revisited once these programs are concluded.

In addition to the three Watershed MOA programs that address failing septics, the 1997 FAD requires two special supplemental technical investigations: the Septic Siting Study and the Galley System Study. The three Watershed MOA programs and two special investigative studies are individually evaluated in the following sections.

3. Sub-Program Assessments

A. Septic System Rehabilitation and Replacement Program

i. Objective - The objective of the Septic System Rehabilitation and Replacement Program is to reduce the threat of surface water contamination from failing or likely-to-fail septic systems serving single or two-family residences in the Catskill/Delaware watershed. To meet this objective, the Program includes inspections, pump-outs and repair or replacement of substandard subsurface disposal systems which do not meet current state and local health laws and are either failing or likely to fail.

ii. Background - Due to economic conditions in the Catskill/Delaware watershed and the lack of enforcement against failing septic systems, it was determined that a New York City-funded program which addresses high priority septic systems would have a much greater chance for success than earlier efforts. The MOA commits the City to provide $13.6 million for the Septic System Rehabilitation and Replacement Program. The Program is managed by the Catskill Watershed Corporation (CWC) in consultation with NYCDEP. In accordance with the FAD, full implementation is to occur within five years from initiation.

iii. Program Assessment

FAD Compliance

In accordance with FAD Tasks 310g-1 and 310g-2, NYCDEP is required to develop and submit a plan for implementing and completing septic rehabilitation and replacement, as well as a prioritized list of systems needing to be addressed. The FAD also requires that the City ensure that mechanisms exist to complete the program. In addition, an annual report (Task 310g-5) identifying all failing or problem systems and corrective measures taken must be submitted. NYCDEP has complied with each of these conditions.

Implementation Assessment

In mid-1997, NYCDEP submitted its plan for prioritizing, implementing and completing the Program. The highest priority septic systems were those confirmed as failing and were subsequently issued Notices of Violation (NOVs). The next priority were septic systems located within the 60-day travel time. The remainder of the Program would then be implemented throughout the watershed, based on

proximity to watercourses. By January 1998 the CWC, in consultation with NYCDEP, approved Septic System Rehabilitation and Replacement Program Rules outlining program standards, the application process and eligible costs.

Two important aspects of this program are that it is voluntary and City-funded. Originally, it was anticipated that because the City would fund necessary septic system repair/replacements, more people would be willing to allow NYCDEP inspectors to evaluate their septic systems and potentially detect failures - clearly an enhancement to the pre-MOA program. The City considered its previous efforts in detecting failing septic systems to be fairly successful; thus, NYCDEP expected this program "enhancement" to add only modestly to the number of failures that it had detected from 1994 through 1996 (see Table VII.1). However, since its inception, the Program has been overwhelmed by the number of homeowners that have requested inspections and were found to have failing systems. Through 1998, the City issued 1,430 NOVs and the CWC repaired/replaced 339 systems. In addition, 334 homeowners were reimbursed for septic systems remediated between November 1995 and December 1997. As highlighted by this very successful program, the amount of failing systems in the watershed had been significantly underestimated.

Due to the overwhelming response to the program, the length of time required to address the backlog of applications increased and funds began to diminish. It was quickly realized that the funding provided by the City through the MOA would not be sufficient to repair/replace every system identified as failing. To address this dilemma, the CWC established a Technical Working Group in mid-1998 to improve the program and determine potential funding needs. The group determined that based on the number of inspections conducted and the number of NOVs issued (1,430 through 1998), approximately 50% of septic systems throughout the west-of-Hudson watershed would need to be repaired or replaced. In December 1998, the CWC restricted participation in the Program to homeowners who had received an NOV prior to January 1, 1999. By the end of 1998, $4 million had been spent, and 757 systems were still in the pipeline for repair or replacement.

In July 1999, the CWC further refocused the Program by restricting participation to properties within the 60-day travel time. This is consistent with the Program=s original prioritization approach. CWC inspectors will contact all homeowners within this area (an estimated 2,200 septic systems according to CWC) offering inspections of their systems. The CWC will reimburse permanent residents 100% and part-time residents 60% of necessary repair/replacement costs. Considering the current backlog of projects and the Program=s funding status, these new rules are a prudent, environmentally sound course of action. In 1999, 740 residential septic systems were repaired or replaced, with 426 more in the process.

A significant concern that is not addressed through the current Program is operation and maintenance. While educational material is available and provided to homeowners on proper septic system maintenance, there is no programmatic follow-up to ensure that systems that have been remediated or replaced (as well as those systems that were inspected and found to be acceptable) are being

maintained. The availability of City-owned WWTPs to accept septic pump-out waste (at no cost) is an incentive for homeowners to maintain their septic systems. However, the City is not accepting waste during winter months at certain plants. Pump-out costs rise as haulers must transport septic waste out of the watershed for proper disposal. (Because of the City=s Watershed Rules and Regulations, land application of septic waste in the watershed has decreased.) Looking forward, proper septic system operation and maintenance is an issue that is intricately tied to the long-term success of the Septic System Rehabilitation and Replacement Program.

Water Quality Assessment

The elimination of failing septics within the watershed reduces the overall basin loadings of fecal coliforms, phosphorus, nitrogen, *Cryptosporidium* and *Giardia* (oo)cysts. In addition, the Septic System Rehabilitation and Replacement Program is a pollution prevention program (i.e., inspections and appropriate follow-up actions address septic system problems before catastrophic failure) - an integral element of the City=s multi-barrier strategy for addressing potential pollution sources. Many of the systems remediated to date are not concentrated in one area, but are scattered throughout the watershed. A measurable water quality benefit associated with scattered, individual septic repair/replacements, is unlikely. However, the collective impacts of failing septics are a contributing factor to water quality degradation. Thus, it is expected that over time, with successful, long-term implementation of the program, water quality to receiving waters and reservoirs will improve. This improvement will be monitored through the City=s watershed-wide monitoring program (see Chapter XIII for an assessment). As the Program continues, it will contribute to the overall non-point source reduction efforts in the watershed.

iv. Conclusions/Recommendations - NYCDEP has met the conditions of the 1997 FAD through establishing a prioritization scheme and creating a mechanism to ensure that septic system failures are addressed and repairs/replacements are conducted. Failing septics are primarily addressed through the Septic System Rehabilitation and Replacement Program. EPA notes that the prioritization scheme does not include septic systems that will be addressed/remediated through the New Sewage Treatment Infrastructure Program and Sewer Extension Program. Thus, ultimate success of the Septic System Rehabilitation and Replacement Program, and its underlying prioritization scheme, requires the expeditious implementation of both of these programs.

Failing septic systems in the New York City watershed are a widespread problem that, prior to the Septic System Rehabilitation and Replacement Program, were not adequately addressed. NYCDEP=s previous strategy for detecting failing systems was unable to discern failure of these systems until the homeowner requested an inspection, or until a neighbor filed a complaint. However, due to the economic incentives in this Program, inspectors were inundated with inspection requests, and the Program became an immediate success. With an estimated 50% of septic systems in the watershed

being identified as substandard, the need for septic system rehab/replacements has continued to rise. With a finite budget, however, this Program will terminate, possibly by the end of this FAD. The operation of failing septic systems within the watershed is unacceptable. **EPA strongly recommends that the City establish an effective, long-term mechanism to detect and remediate failing systems which does not rely on the previous, inadequate detection system. EPA recommends that this system be established prior to the termination of the existing Septic System Rehabilitation and Replacement Program and include Catskill/Delaware watersheds east-of-Hudson.**

Significant resources have been committed to remediate failed septic systems. Proper operation and maintenance of septic systems, after they have been repaired or rehabilitated, is the most cost-effective approach to assure long-term reliability. **EPA recommends that the City develop a comprehensive program, with appropriate incentives, to ensure proper operation and maintenance of septic systems in the watershed.** One existing incentive is the City=s acceptance (at no cost) of pump-out waste at its new WWTPs. This activity is important to the immediate and long-term success of the Program. Currently, however, the City is not accepting waste during winter months at certain plants. **EPA recommends that the City and State expeditiously resolve this issue so that City WWTPs can accept pump-out waste on a year-round basis.**

B. New Sewage Treatment Infrastructure Program

i. Program Description and Objective - The primary objective of the New Sewage Treatment Infrastructure Program (NSTIP) is to prevent water quality degradation associated with failing (or soon-to-be failing) septic systems in west-of-Hudson communities. To achieve this objective, the Program aims to construct new municipal WWTPs, community septic systems or septic districts in up to 22 communities. This City-funded Program is being conducted in accordance with the Watershed MOA, which identifies "priority" communities for the allocation of NSTIP funds ($75 million). This Program is one of the components of FAD Deliverable 310e-1, "a methodology for prioritizing routine inspections to detect septic system failures," submitted to EPA in December 1996. Implementation of this Program is necessary to the success of the City=s overall Septic System Program.

A secondary objective to this Program has evolved over the past two years. It entails decommissioning small, privately-owned WWTPs in the new sewer districts that receive NSTIP funding and redirecting their waste streams to new NSTIP facilities. These more efficient and reliable municipal systems will provide better treatment and a higher standard of operator attention and expertise. In addition, consolidation will reduce the "universe" of WWTPs in the watershed resulting in more concentrated and efficient use of compliance/enforcement oversight resources. Owners of these small WWTPs have the option to either upgrade their facilities (through the Regulatory Upgrade Program) or decommission them and connect to the new sewer districts.

ii. Program Assessment

FAD Compliance

The New Sewage Treatment Infrastructure Program does not have any specific FAD milestone or completion deadlines; nor are there any deadlines in the MOA or City=s Watershed Rules and Regulations (WR&R). However, an agreement among the City, CWC, and New York State Environmental Facilities Corporation that lays out responsibilities for implementing the Program (attachment SS to the MOA) includes an end date of January 2007 (with a five year extension if agreed upon by the parties). Because the NSTIP in one of the components of the City=s Septic System Program, EPA tracks progress through the City=s FAD *Annual Report* (Task 901a) and *Quarterly Report on the Status of Implementing Projects Designed to Reduce Non-point Source Pollution* (Task 308i). These reports provide sufficient information to evaluate the progress of this Program. EPA=s major concern at this point are the impacts that delays in the Regulatory Upgrade Program may have on the timely completion of the NSTIP (see discussion below).

Program Implementation Assessment

According to the contract agreement contained in the Watershed MOA, the NSTIP is being implemented in four phases: Phase I is the study period, expected to take 18 months; Phase II is the community planning period expected to take 1-2 years; Phase III is the design period expected to take 1-2 years; and Phase IV is the construction period expected to take 2-5 years.
Thus, the first five years of the Program are devoted to study, planning and design and the second five years are devoted to construction. Construction is anticipated to begin in 2002. Based on preliminary cost proposals, it appears that the Program will only be able to address the first seven priority communities (Hunter, Fleischmanns, Windham/Hensonville, Andes, Roxbury, Phoenicia, and Prattsville). These communities are finalizing their studies and are expected to complete the community planning stage during 2000. Thus far, the Program appears to be on schedule.

Ten existing WWTPs located within NSTIP communities have been identified by NYCDEP for potential tie-in to new municipal facilities. Out of the ten, NYCDEP reported that seven have expressed interest in decommissioning their plants, consisting of approximately 135,000 gpd total combined SPDES flow, and connecting to new WWTPs constructed under the NSTIP. (See Table VIII.8 for a facility and sewer district listing.) In 2000, during the community planning stage (Phase II) of the NSTIP, the proposed service areas and flow capacities of the new WWTPs will be finalized. It is also during this stage that a decision will be made as to whether the existing facilities should decommission and connect to the new WWTPs or should instead be upgraded pursuant to the Regulatory Upgrade Program. Current delays in implementation of the Regulatory Upgrade Program (see Chapter VIII), however, will delay the completion of this stage. Owners of small, private WWTPs and their respective communities are reluctant to commit to the decommission/connection option absent agreed upon costs and resolution of O&M issues associated with their regulatory upgrades. (The City

has agreed that costs not expended on a regulatory upgrade will be diverted towards construction of the new WWTP.) Because of delays in the Regulatory Upgrade Program, even under the most optimistic estimates, final designs with upgrade costs are not expected to be completed and approved before spring 2001, potentially delaying the NSTIP for over a year.

In addition, a FAD compliance problem presents itself if the decision is made to decommission an existing facility and redirect the waste to a new facility constructed under the NSTIP. The seven existing facilities are currently slated to be upgraded to advanced tertiary treatment by May 2002 (in accordance with the FAD, MOA and WR&R). As discussed above, there are no deadlines in the NSTIP. Regardless of whether the NSTIP hookup option is chosen, the WR&R enhanced treatment requirements for these existing facilities must be met within the timeframe of the WWTP Upgrade Program.

Water Quality Assessment

Implementation of the NSTIP can potentially proceed through the duration of the contract agreement, until 2007 or later. Thus, water quality benefits from this program will not be measurable until well after the expiration of this FAD. However, in the long-term, water quality will benefit through the connection of new municipal systems and the elimination of non-point source pollution (from failing or likely-to-fail septics) that are in close proximity to streams. In addition, another potential benefit is more reliable wastewater treatment (through increased operator and enforcement attention) with the consolidation of existing wastewater point sources and connection to new municipal systems. Through its watershed-wide stream monitoring program, NYCDEP has sampling stations set up downstream of most of the towns that are slated for new WWTPs. In addition, stream biomonitoring stations are set up at two locations, Fleischmanns and Hunter, and pathogen sampling stations are set up in Roxbury, Prattsville, and Hunter. All facilities will be subject to sampling requirements through their SPDES permits.

iii. Conclusions/Recommendations - The NSTIP is proceeding in accordance with the MOA. However, it appears that delays in the Regulatory Upgrade Program may negatively impact the NSTIP schedule**. EPA recommends that the City work with facility owners to develop upgrade cost and flow information in a timely manner for those seven facilities that may opt out of the Regulatory Upgrade Program and decommission/connect to a new WWTP in the NSTIP. EPA recommends that this information be provided to the affected communities as soon as possible for the NSTIP to remain on course.**

EPA supports the consolidation of small, private WWTPs through the NSTIP. This effort should result in more efficient and reliable wastewater treatment systems with higher levels of operator attention and expertise. These new systems, however, have no enforceable schedule for completion other than the

2007 contract expiration date, which can be extended five more years if necessary. Existing WWTPs are required to be upgraded by May 2002 (per the FAD, MOA, and WR&R). Regardless of whether the NSTIP hookup option is chosen, the waste going to existing facilities is subject to enhanced treatment ("upgrades") requirements and timeframes of the WR&R. **EPA recommends that NYCDEP develop and implement interim measures to meet the WWTP regulatory upgrade mandates for those facilities that have made a commitment to connect to a NSTIP facility.**

C. Sewer Extension Program

i. Program Objective and Description - The objective of the Sewer Extension Program is to alleviate existing water quality problems from failing or likely to fail septic systems. This will be achieved by constructing extension sewer lines to existing sewage collection systems that serve City-owned WWTPs in the Catskill/Delaware watershed. In accordance with Paragraph 123 of the Watershed MOA, the City agreed to provide up to $10 million for this program. The City serves as program manager, in consultation with the CWC, and prioritizes areas for sewer extensions in west-of-Hudson communities. WWTPs receiving additional sewage are Grahamsville, Grand Gorge, Pine Hill, Margaretville, and Tannersville. (In the Kensico reservoir basin, the 1997 FAD requires the NYCDEP to work with Westchester County to connect all septic systems located within existing municipal sewer systems pursuant to the local sanitary code, including the decommissioning and connection of the failed Jenny Clarkson community septic system. The sewer extension program for Kensico is discussed in detail in the Kensico Modeling and Remediation Section of this report.)

ii. Program Assessment

FAD Compliance

Although implementation of the Sewer Extension Program is not a specific FAD deliverable and therefore has no FAD milestones, it is one of the mechanisms being used by the City to meet the goals of the FAD-mandated Septic System Program. Therefore, EPA monitors progress to ensure that adverse water quality impacts from failing or potentially failing septic systems are adequately addressed.

Implementation Assessment

With water quality being the primary selection factor, NYCDEP reviewed, evaluated, and prioritized proposals to construct extension sewers to existing collection systems serving the five City-owned WWTPs. Through 1998, the City worked with CWC and local communities to establish an acceptable prioritization methodology and pursued contract agreements with communities wishing to serve as project managers. Communities began working with NYCDEP in early 1999 to develop and adopt Sewer Use Ordinances. Design and construction work is expected to begin in 2000. The Program includes 14 extensions in five towns (Neversink, Hunter, Roxbury, Middletown and

Shandaken). Based on review of the City=s progress to date, the Program is meeting the intent of the FAD.

Water Quality Assessment

This Program will completely eliminate a number of failing or likely to fail septics that are potential non-point sources of pollution. Instead, waste will be routed to the City=s advanced tertiary treatment facilities, which include microfiltration and phosphorus removal. Because the Sewer Extension Program is, in part, a "protection" program (i.e., protecting against the high probability of future septic system failures), success will be measured by maintaining high water quality in nearby streams (See Chapter XIII for a discussion on the City=s watershed-wide monitoring program). In addition, because these extensions tie in to the recently completed, City-owned WWTPs, measured water quality enhancements from that Program (see Chapter VIII) will also reflect the success of this Program.

iii. Conclusions/Recommendations - Although there are no specific FAD requirements for the Sewer Extension Program, septic systems within the sewer service area of the City-owned WWTPs should be connected to these facilities as soon as possible to address FAD objectives. Successful implementation of this program will partially satisfy the goals of the 1997 FAD Septic System Program.

D. Special Investigative Studies and Reviews

Septic Siting Study

i. Objective - The Septic Siting Study is intended to provide a technical assessment of the adequacy of the NYSDOH requirement for a 100-foot separation distance (10 NYCRR Appendix 75-A) between septic system absorption fields and watercourses and wetlands. Study results and conclusions will inform any changes to the NYSDOH septic system setback regulations.

ii. Background - While failing septic systems are known to contaminate surface waters by contributing nutrients and pathogens, it has generally been accepted that a properly designed, constructed and operated septic system which meets NYSDOH=s setback requirements will not pose a contamination threat. EPA questioned this premise in the January 1993 FAD. As a result, NYCDEP performed a literature search to assess the potential for pathogens to travel beyond the prescribed setback distance. Because the results proved inconclusive, EPA required NYCDEP to conduct a study to determine whether the 100-foot NYSDOH setback requirement was protective of surface water in the New York City watershed.

iii. Assessment

FAD Compliance

The FAD contains several key milestones for the implementation of the study, along with a requirement to submit a final report with study results and implications on setback distances. The study was completed and the final report submitted in December 1999 in accordance with the FAD. Upon analysis of the results, the FAD requires the City to provide NYSDOH with recommendations for modifications to 10 NYCRR Appendix 75-A and, if necessary, formally request NYSDOH to revise the Watershed Rules & Regulations based on the study results. This FAD requirement was met on February 28, 2000.

In addition to FAD requirements imposed on NYCDEP, the MOA includes a NYSDOH commitment to review the study results and recommendations. The MOA further states that if NYSDOH determines that there is significant pathogen transport beyond the 100-foot separation distance, it will determine appropriate changes to 10 NYCRR Appendix 75-A. If NYSDOH does not adopt the recommendation or if it modifies the recommendation of the final report, NYSDOH will issue a written determination setting forth its rationale. NYCDEP=s formal request to NYSDOH for revisions to the regulations is too recent (February 28, 2000) for discussion in this mid-course FAD review.

Study Implementation and Discussion

The complexity of the project and the difficulty of finding suitable sites necessitated several changes to the study design (Final Report for the Septic Siting Project, NYCDEP, 1999). The final project design consisted of six full-time residences with septic systems that met Appendix 75-A standards. The sites underwent a series of pathogen spiking events; wells were placed 100 feet from the septic system and were monitored for chemical and biological parameters during wet (spring) and dry (autumn) conditions (Revised Quality Assurance Plan, NYCDEP, 1998).

Despite the multiple challenges in designing and implementing the study, NYCDEP developed a study plan satisfactory to the involved agencies. However, through the course of the study, NYSDOH questioned the appropriateness of the seed size (approximately 10^{11} organisms) and spike location. NYSDOH claimed that the amount of spiking material was too large to represent septic tank effluent at the distribution box location (after the septic tank). A February 1999 meeting was held to provide preliminary data results and a project status update, and to discuss the seed size and spiking location issues raised by NYSDOH. NYCDEP and Dr. Mark Sobsey, the principle investigator, addressed the issues to EPA=s satisfaction.

In the final December 1999 report, NYCDEP stated that, despite the detection of pathogen mimics at the 100-foot distance in certain systems, conclusive evidence does not exist to support recommendations to increase the 100-foot set-back distance. However, NYCDEP does recommend changes to the New York State septic regulations pertaining to proper design and construction. NYCDEP also provides recommendations for research to be undertaken at the state or national level

(Final Report for the Septic Siting Project, NYCDEP, 1999). EPA will provide comments on the study and on NYCDEP=s recommendations soon after completion of this mid-course FAD review.

Water Quality Assessment

Pathogen surrogates were found in monitoring wells 100 feet from the septic system at each of the sites, confirming that pathogens can travel through the subsurface, beyond the 100-foot setback prescribed in the regulations. The frequency of spiking material recovery and recovery concentrations varied seasonally and among sites. Very few surrogates were detected at two of the sites, while monitoring at two other sites detected surrogates throughout most of the study period. Study results indicate that pathogen transport increases with rainfall and that the depth to watertable influences transport.

iv. Conclusions/Recommendations - Results from the Septic Siting Study showed that pathogens can travel in the subsurface beyond the 100-foot setback prescribed in NYSDOH's regulations. In response, NYCDEP has recommended changes to the New York State septic regulations pertaining to proper design and construction to mitigate this concern. In accordance with the MOA, NYSDOH will review the study results and recommendations, and determine appropriate changes to 10 NYCRR Appendix 75-A. **EPA supports the City's recommendations as minimum actions to be considered to address pathogen travel beyond the 100-foot setback. EPA recommends that NYCDEP expeditiously submit all information related to the study and that NYSDOH utilize the study results as the technical basis for a prompt, regulatory review of its setback requirements in the watershed. In addition, EPA recommends that the City expeditiously propose modifications to its Watershed Regulations that reflect any revisions made by NYSDOH to 10 NYCRR Appendix 75-A.** (EPA will provide specific comments on the study soon after completion of this FAD mid-course review.)

Based on the results of the Septic Siting Study, continued concern for the transport of pathogens from septic systems is justified. The study was designed to determine presence/absence, rather than to measure the specific distance that pathogens travel beyond 100 feet, or to examine the fate and transport mechanisms of pathogens within the subsurface. **EPA recommends that NYCDEP and NYSDOH support research on the impacts and fate and transport mechanisms of pathogens in the subsurface.**

Galley Study

i. Objective - The objective of the Galley Study is to assess the effectiveness of galley systems in treating sewage as compared to conventional absorption trench systems. An effective comparison requires systems in similar soils with similar separation to groundwater. In accordance with the FAD and MOA, if it is determined that the galley systems studied do not adequately treat sewage when

compared to conventional septic systems, the City shall propose appropriate revisions to the Watershed Rules and Regulations which may include limitations on the use of such galley systems.

ii. Background - Galley systems are septic systems with large design flows that contain septic tanks and leaching chambers (called "galleys") installed in soils under impervious or pervious surfaces. Some parties to the MOA, including EPA, were concerned that galley systems such as those installed in Westchester and Putnam Counties may be incapable of effective treatment. In order to address this concern, a study was proposed to test the effectiveness of these systems as compared to conventional absorption trench systems, utilizing systems in Westchester and Putnam Counties.

As a result of the MOA negotiations, the Galley System Study was included in Paragraph 169 of the MOA and was later added to the FAD. The MOA assigns responsibility to NYSDOH and NYCDEP to select the individual sites to be used for the Galley Study and to obtain landowner agreements to participate in the study. The MOA requires the City to propose appropriate revisions to the Watershed Rules and Regulations if "the Galley Study shows that certain types of galley systems, used in Westchester and Putnam counties and allowed under the regulations, do not adequately treat sewage when compared to conventional septic systems."

iii. Assessment

FAD Compliance

FAD deliverable 310h-2 requires NYCDEP to complete the Galley System Study and submit a final report assessing galley systems' treatment effectiveness by March 31, 2000. An interim report was submitted by the FAD due date of March 31, 2000. The report contains a preliminary analysis of the data. NYCDEP will submit additional information shortly. The City will formally request NYSDOH to revise the Watershed Rules and Regulations, if necessary, based on results of the Galley System Study by May 31, 2000.

Study Implementation and Discussion

A Galley Study workgroup, charged with preparing and finalizing the study scope, included members of USEPA, NYSDOH, NYCDEP, Putnam County Department of Health, Westchester County Department of Health, and the Riverkeeper. After NYCDEP, in consultation with USEPA and the workgroup, developed a study protocol which was satisfactory to all the involved agencies, a Quality Assurance Project Plan was developed for use in the study. SUNY ESF performed the Galley Study field work, data collection, and analysis, by means of an Intergovernmental Agreement with NYCDEP, and has reported progress to the workgroup on a periodic basis.

Four galley sites in Putnam County were chosen to be part of the study: three unpaved systems and one paved system. For the comparison portion of the study, two conventional residential systems from the

Septic Siting Study were later selected. Due to lack of septic system influent and subsequent lack of groundwater in monitoring wells, one of the unpaved sites had to be eliminated from the study. In addition, another of the unpaved sites was paved over during the course of the study. Ultimately the study used two unpaved sites and two paved sites.

Site characterization was performed at all of the galley system sites to identify and locate, both horizontally and vertically, groundwater conditions and significant soil and rock masses, and to establish the characteristics of subsurface materials. Field methods included ground-penetrating radar and electromagnetic induction as well as direct observation. Using the site characterization information, one up-gradient and three down-gradient wells were installed at each site to collect weekly grab samples for analysis of typical wastewater constituents. The down-gradient wells were located approximately 10 feet from the edge of the system and the up-gradient wells were set at a minimum of fifteen feet up-gradient from the system.

Although each of the sites was triangulated to determine proper well placement, data show that groundwater was unevenly distributed across the down-gradient wells for some of the galley systems. This phenomenon was not anticipated at the study design phase and should be addressed in the final report. Another unanticipated phenomenon occurred when some of the distribution fields exhibited reverse groundwater gradients (i.e., down-gradient wells had higher watertable elevations than up-gradient wells) due to mounding. While some mounding was anticipated, the mounds associated with some of the galley sites were much larger than expected. These two issues complicate the groundwater data analysis and methodology selection for making the comparison between systems.

In preparation for submittal of the Galley Study Report, NYCDEP is reviewing and performing statistical analysis on the study data. To support data analysis, SUNY ESF used a groundwater flow model (FEMWATER) to test site behavior at one location under wet and dry conditions. SUNY is currently designing a methodology for comparing the two types of systems.

iv. Conclusions/Recommendations

NYCDEP has completed the field work for the Galley Study. Preliminary data analysis has been performed and a detailed analysis is currently being performed by NYCDEP's contractor. Supplemental information (including statistical analysis of the data) will be submitted to EPA shortly which will allow a full analysis of the Galley System Study results. Though it would be premature to assess the implications of the study until the additional information becomes available, it is clear from the data that have been collected and analyzed to date that issues such as groundwater mounding should be considered when determining effectiveness of Galley type septic systems or when determining appropriate setback distances to sensitive waterbodies. It is also clear that groundwater flow plumes are difficult to predict for all flow scenarios. These factors should be considered in the analysis of the study data. Tools such as the groundwater flow model used by NYCDEP in this study may prove useful in predicting groundwater behavior, such as mounding, in septic systems in the watershed. **EPA**

recommends that NYCDEP evaluate these tools for their potential use in characterizing nonpoint source pollution due to septic systems. EPA recommends that the City complete expeditiously its analysis to assess the effectiveness of galley systems in treating sewage as compared to conventional absorption trench systems.

EPA recommends that NYCDEP promptly propose modifications to the Watershed Regulations that reflect any revisions made by NYSDOH to 10 NYCRR Appendix-75-A.

VIII. Wastewater Treatment Plant Compliance/Upgrade Program

1. Program Description and Objectives

With over 100 wastewater treatment plants (WWTP) discharging within the New York City watershed, the quality of treated effluent is one of the most significant factors that impacts immediate and long-term drinking water quality for the City. The New York State Department of Environmental Conservation (NYSDEC) manages a federally-approved New York State Pollutant Discharge Elimination System (SPDES) program which regulates point sources through the issuance and enforcement of discharge permits that incorporate technology and water quality based effluent limits. The overall objectives of the WWTP Compliance/Upgrade Program are to use best available control technologies along with enhanced environmental compliance tools to substantially reduce or eliminate microbial and nutrient loadings from WWTPs into the New York City water supply watershed and to ensure continuing compliance with SPDES permit requirements. To meet these objectives and to comply with the 1997 FAD, NYCDEP is implementing three interconnected programs.

WWTP Inspection and Compliance Program. As required by the 1997 FAD, NYCDEP monitors and reports on the operation and discharge of WWTPs in accordance with their SPDES permit requirements at least on a quarterly basis. Since the 1993 FAD, NYCDEP has been working with the NYSDEC to evaluate and address SPDES compliance concerns in an expeditious manner. In 1993, NYSDEC executed a inter-agency memorandum of understanding with the NYCDEP (DEC/DEP MOU) to establish compliance and enforcement protocols which would best utilize agency resources to meet the goals of the FAD. As a result, the NYCDEP WWTP Inspection and Compliance Program has been a significant enhancement to the NYSDEC SPDES program.

SPDES Upgrade Program. In an evaluation conducted pursuant to EPA's 1993 FAD, NYCDEP determined that existing SPDES permits in the watershed needed to be enhanced to meet the City's goals of protecting water supply reservoirs from the threat of contamination. First, NYCDEP has coordinated with NYSDEC in modifying SPDES permits to establish enhanced current (interim) and final effluent discharge limitations and self-monitoring/reporting requirements. Second, through the 1997 Watershed MOA, the City committed $5 million towards equipment repair/replacement of original treatment facilities in the Catskill/Delaware watershed which cannot reliably meet their interim SPDES permit requirements.

Regulatory Upgrade Program. To comply with the City's 1997 Watershed Rules & Regulations (WR&R), all WWTPs in the watershed are required to be upgraded to achieve treatment capability for pathogen removal (through microfiltration or approved equivalent) and phosphorus reduction by May 2002. This deadline is specified in the MOA, WR&R, and the 1997 FAD. These treatment upgrades are above and beyond the interim SPDES treatment requirements and are required in order to meet final SPDES permit requirements. When the regulatory upgrades are completed, additional

monitoring/reporting will be required to ensure that the advanced pathogen/phosphorus removal technologies are working optimally such that WWTP final discharge limitations are continuously met.

2. Background

Protecting reservoir stream tributaries from WWTP point source contamination is one of the conditions for obtaining filtration avoidance for the Catskill/Delaware Watershed. To comply, in 1993, NYCDEP consulted with the NYSDEC on the operational status of all SPDES permitted dischargers in the City's watersheds. This effort resulted in compilation of 110 SPDES dischargers: 38 surface water dischargers (including six City-owned WWTPs), 3 subsurface dischargers and 1 land application discharge in the Catskill/Delaware watershed (5.5 million gallons/day total flow) and 68 surface water dischargers in the Croton watershed (6.5 million gallons/day total flow). NYCDEP and NYSDEC then began to assess the operational integrity of these facilities to comply with their existing SPDES permits. After extensive review of all WWTPs, it was determined that the SPDES self-monitoring and reporting was not consistent and reliable to assess the actual compliance status of many facilities. During this review, NYCDEP also concluded that its six City-owned WWTPs were not operating at levels adequate to meet their SPDES requirements, and therefore, substantial facility upgrades were necessary.

In accordance with the January 1993 FAD, NYCDEP developed and implemented a strategy to evaluate the compliance status and address operational needs of the non-City owned WWTPs. It also developed a schedule to upgrade all six west-of-Hudson, City-owned WWTPs by September 1997. In the December 1993 FAD, EPA required NYCDEP to develop and implement an aggressive monitoring and inspection program at all WWTPs. The objective of this program was to obtain the necessary information, not provided by the current SPDES permits, to effectively assess and initiate corrective action for non-compliance. EPA's mid-course review will focus on SPDES permit compliance and facility upgrade progress at the 42 WWTPs located in the Catskill/Delaware watershed covered under the 1997 FAD as shown in Table VIII.1 (EPA also oversees the 68 SPDES surface water dischargers in the Croton watershed through the November 1998 Federal Consent Decree).

Table VIII.1 -New York City Catskill/Delaware Watershed
SPDES Sewage Treatment Plants

Large Facilities (>50,000 gallons/day)		Small Facilities (<50,000) gallons/day	
Facility	Permitted Flow (mgd)	Facility	Permitted Flow (mgd)
1. [1]Ultra Dairy, Inc.	0.200	1. Belleayre Ski Center	0.029
2. Village of Delhi	0.515	2. BOCES-West Delaware	0.003
3. Village of Hobart	0.160	3. [i] Camp Loyaltown, Inc.	0.021
4. Hunter Highlands	0.080	4. [i] Camp Nubar	0.013
5. Liftside Ski	0.081	5. [i] Camp Tai Chi	0.014
6. NYC-Grahamsville	0.180	6. [i] Camp Timberlake	0.034
7. NYC-Grand Gorge	0.500	7. Colonel Chair Estates	0.030
8. NYC-Margaretville	0.400	8. Crystal Pond	0.036
9. NYC-Pine Hill	0.500	9. [i] Elka Park Estates	0.010
10. NYC-Tannersville	0.800	10. Forester Lodge	0.005
11. Roxbury Run Village	0.100	11. [2]Frog House Pub	0.002
12. Ski America	0.060	12. [i] Golden Acres Farm	0.006
13. Village of Stamford	0.500	13. [i] Harriman Lodge	0.020
14. Village of Walton	1.170	14. [i] Latvian Church Camp	0.007
		15. Mountain View Estates	0.013
		16. [2]Mountainside Farms	0.049
		17. Mountainside Inn	0.003
		18. [2]NYC-Chichester	0.009
		19. Onteora High School	0.027
		20. Penn Quality Meats	0.025
		21. [i] Regis Hotel	0.010
		22. RonDeVoo Restaurant	0.001
		23. Olive Woods	0.013
		24. [i] SEVA Institute	0.008
		25. S. Kortright Center	0.020
		26. [i] Thompson House	0.005
		27. Whistle-Tree Devlp.	0.027
		28. [i] Clear Pool Camp	0.020

KEY

* - Seasonal facilities: permitted to discharge 6 months or less.

[1] - Permitted for land application discharge under SPDES.

[2] - Permitted for subsurface discharge under SPDES.

To more effectively address SPDES concerns in the watershed and comply with FAD requirements, NYSDEC and NYCDEP technical and legal staff developed the DEC/DEP MOU which was signed by the Commissioners of each agency in September 1993. The intent of the DEC/DEP MOU is to coordinate SPDES compliance and enforcement activities between agencies to attain a higher level of compliance in the watershed. A program was established by NYSDEC Division of Water in December 1993 to coordinate this effort.

The program increased monitoring and reporting requirements for all facilities discharging to surface water (consistent with the 1993 FAD), specified lead enforcement oversight authority between NYSDEC and NYCDEP, established the quarterly Watershed Enforcement Coordination Committee (WECC) process, and provided for coordination of operator training, technical assistance, and specific enforcement response protocol. Out of the 42 WWTPs of concern in the Catskill/Delaware Watershed, NYSDEC has retained lead enforcement oversight authority for the 14 largest surface water dischargers (>50,000 gpd), plus the New York City-owned subsurface discharger, Chichester, and has designated lead enforcement oversight authority (Clean Water Act [CWA] Section 505 Citizen Suits) for the other 24 smaller surface water dischargers (<50,000 gpd), two subsurface facilities (Frog House Restaurant and Mountainside Farms) and a land application facility (Ultra Dairy, Inc.) to NYCDEP. State-wide SPDES permit issuance is administered by NYSDEC and compliance is primarily tracked through self-monitoring by Discharge Monitoring Reports (DMRs) submitted to NYSDEC, regulatory inspections and a NYSDEC sampling program.

At the quarterly WECC meetings, representatives from NYSDEC, NYCDEP, NYSDOH, and EPA discuss enforcement activities and progress in resolving compliance problems of SPDES dischargers in the watershed. NYSDEC and NYCDEP also coordinate monitoring, enforcement, and technical assistance strategies to assure timely resolution of non-compliance. Data sharing between NYSDEC and NYCDEP is also coordinated through the WECC process. To expedite appropriate enforcement action, NYSDEC and EPA accept NYCDEP's use of Section 505 Citizen Suit authority under the CWA as a formal enforcement action when used in accordance with the DEC/DEP MOU.

The Watershed MOA provided a mechanism to advance the watershed protection activities contained in the 1997 FAD including the upgrade of all surface-discharging WWTPs to enhanced levels of treatment. These enhanced levels of treatment, including installation of microfiltration or an approved equivalent technology and phosphorus removal, should effectively minimize the microbial and nutrient loads associated with sewage treatment plants. In accordance with the MOA, the WR&R, and 1997 FAD, the City is required to complete regulatory upgrades for all WWTPs in May 2002, five years from the effective date of the WR&R. The following is a detailed description and assessment of the three program areas of the WWTP Compliance/Upgrade Program.

3. Sub-Program Evaluations

A. WWTP Inspection and Compliance Program

i. Program Objective - The objective of the WWTP Inspection and Compliance Program is to assure compliance with SPDES permit requirements and reduce pollutant loading impacts from municipal and privately owned WWTPs operating in the NYC drinking water supply watersheds. Major concerns in the past have been 1) the need for SPDES permit renewal modifications;
2) inconsistent and unreliable SPDES self-monitoring reporting (DMR's) to assess compliance status at approximately 70% of the facilities; 3) severe operational limitations that existed at most facilities due to equipment age/disrepair, overloading, inadequate operator attention and other factors; and 4) need for enhanced compliance/enforcement strategies. NYCDEP pursues this objective through monitoring WWTP discharges for SPDES regulated pollutants, monitoring receiving stream conditions, and assessing the operational integrity of WWTPs through on-site inspections.

ii. Program Background - Prior to January 1994, only WWTPs discharging in the New York City watershed classified as significant municipal or industrial facilities (EPA "majors" discharging 1.0 million gallons per day or greater) were tracked by NYSDEC and EPA in the EPA Permit Compliance System (PCS) database. The PCS database is where the DMR data is entered and stored for use by NYSDEC and EPA for compliance/enforcement purposes. Of the total 110 WWTPs, only three SPDES dischargers in the New York City watersheds were classified as EPA majors. Approximately 70% of SPDES dischargers in the watersheds were not required to submit DMR's and were not subject to surveillance oversight by NYSDEC.

By January, 1994, all NYC watershed facilities east- and west- of Hudson were elevated to a level equivalent to the EPA major status by NYSDEC and therefore, were required to begin submitting DMR's. Also, consistent with the guidance for the statewide significant discharger class and Addendum G (Sampling and Inspection Program) of the DEC/DEP MOU, all WWTPs started to receive routine oversight by NYSDEC and NYCDEP. As a result of the EPA FADs and the MOA, monitoring is much more intensive for all WWTPs in the New York City watershed than for other SPDES dischargers outside of the watershed.

iii. Program Strategy - There are three elements to the City's Inspection and Compliance Program strategy: (1) sampling/inspection, (2) enforcement, and (3) compliance assistance. These elements, which must be completely integrated to be successful, are presented in more detail below. (As described previously, several enhancements to (1) and (2) were begun in 1994.)

Sampling/inspection: NYCDEP revised its WWTP compliance/enforcement strategy, in consultation with NYSDEC, to address inadequate SPDES permit requirements and lack of self-monitoring data. Through FAD Task 312d-1 of the 1997 FAD and previous FADs, EPA requires NYCDEP to conduct grab samples twice per month with at least one set of sampling conducted annually in accordance with the SPDES permits at all non-City-owned WWTPs. NYCDEP conducts weekly monitoring at all City-owned WWTPs. FAD Task 312e requires NYCDEP to conduct quarterly comprehensive on-site inspections at all WWTPs. The NYCDEP also conducts a similar on-site inspection and sampling regime for the 68 Croton watershed WWTPs under the Croton Filtration Consent Order.

This enhanced sampling/inspection program is very important since, through the mid-1990's, inconsistent and unreliable reported self-monitoring data did not allow an adequate determination of the compliance status of approximately 70% of WWTPs in the watershed. Therefore, NYCDEP has relied on supplemental monitoring data supplied by its program since the 12/93 FAD to address compliance problems. NYCDEP follows up on these problems through either direct technical assistance or Section 505 Citizen Suits under the federal CWA. This program has also supplied additional information for new, modified permits to be developed and issued by NYSDEC. These new permits address the needed monitoring and reporting enhancements identified through the sampling/inspection program.

Where compliance problems persist or data discrepancies are suspected, NYCDEP is required to conduct additional sampling for SPDES regulated pollutants. In an additional program enhancement, since 1997, NYSDEC has been conducting on-site inspections and sampling under federal Safe Drinking Water Act grant assistance to supplement NYCDEP's inspection/sampling efforts.

Enforcement: Sampling data are shared between NYCDEP and NYSDEC through the WECC process for use in compliance assistance activities or, if necessary, formal enforcement actions. Formal enforcement actions are usually initiated by utilizing EPA's criteria for significant non-compliance (SNC) under the NPDES program. The EPA criteria for SNC violations are established under "acute" and "chronic" and "reporting" definitions. "Acute" SNC violations are defined as a discharge of a specific pollutant that has exceeded the technical review criteria (TRC) by 40% over the permitted limit for non-toxic pollutants and 20% over the permitted limit for toxic pollutants in any two months of a consecutive six month reporting period. "Chronic" SNC violations are defined as a discharge of a specific non-toxic or toxic pollutant that has exceeded the permitted limit in any four months of a consecutive six month reporting period. "Reporting" SNC violations are defined as non-submittal of a DMR after 60-days of the close of the monthly reporting period or failure to submit reports 90-days after the required date by SPDES permits or formal enforcement actions. EPA monitors SNC on a quarterly basis and requires resolution of the SNC violations or initiation of a formal enforcement action after two consecutive quarters of reported SNC by a facility. On September 30, 1997, NYCDEP formally outlined these procedures replacing those contained in *New York City's 1993 Long-Term Watershed Protection and Filtration Avoidance Program*.

In April 1998, NYSDEC enhanced its enforcement program in the New York City watershed by revising its guidance to identify "priority" violations for surface water dischargers in certain drinking water supplies (including the NYC watershed) which trigger quicker enforcement response time than required under the EPA SNC criteria. NYSDEC identifies "priority" violations as a discharge that has exceeded the TRC of 40% over the permitted effluent limit of a non-toxic pollutant in any one month, or the permitted effluent limit in any two months of a consecutive six month period. For toxic pollutants, "priority" violations are identified as an exceedance of the permitted effluent limit in any one month. At the same time, NYSDEC streamlined its enforcement response time with the "short-form" penalty order designed to address priority violations consistent with the enhanced level of oversight. As a result of the new NYSDEC "priority" violations criteria and the collaborative enforcement/compliance assistance efforts at WECC, all compliance issues have been resolved within two consecutive quarterly reporting periods or addressed with a formal enforcement action by NYSDEC or NYCDEP.

Compliance assistance: To enhance compliance assistance, the 1997 FAD includes tasks to ensure that the City develops and implements a "circuit rider" technical support plan (FAD Task 312q). This provides WWTP owners and operators on-site technical assistance for the operation and maintenance of all WWTPs in the New York City watershed to attain compliance with their SPDES permit requirements. The technical support plan was submitted to EPA in November 1997 and approved for implementation.

EPA closely monitors the implementation of NYCDEP and NYSDEC WWTP inspection and compliance assistance activities through quarterly WECC meetings. Through the WECC, NYCDEP coordinates with NYSDEC to meet this objective by implementing various compliance methods such as securing capital funds for process improvements, operator training, and the "circuit rider" technical assistance program. NYCDEP reports sampling and inspection results to EPA and NYSDEC on a quarterly basis. This information is used at WECC meetings to assure timely and appropriate compliance follow-up. NYCDEP's goal has been to appropriately intervene and improve WWTP compliance without necessarily resorting to litigation. In accordance with FAD Task 312r, the NYCDEP submits quarterly status reports on the plan's implementation. EPA supports a coordinated effort between NYCDEP and NYSDEC technical support staff as one of the conditions for approval of the "circuit rider" program. Since its approval, NYCDEP, in cooperation with NYSDEC's New York City Watershed Section staff, has developed an effective program of technical assistance and operator training. Continued successful implementation will ensure that all WWTP owners receive a wide range of expertise to help them understand and meet water quality goals in a timely and effective manner.

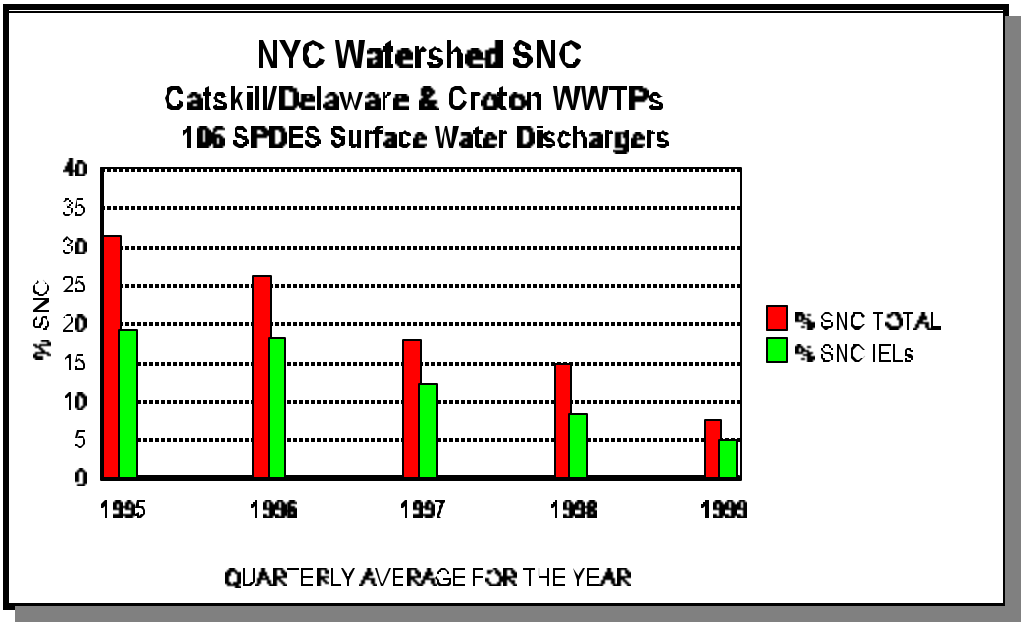
iv. Program Assessment

FAD Submittal Compliance: All quarterly NYCDEP sampling data and on-site inspection reports have been submitted under FAD Task 312d-1 and 312e on time, and the information presented is consistent with program objectives. Technical assistance status reports under FAD Task 312r are submitted on time and consistent with FAD goals. The reports are useful tools for NYCDEP,

NYSDEC, and EPA to target compliance problems at their earliest stages and take corrective action as soon as possible. In addition to the effectiveness of NYCDEP sample monitoring, on-site inspections reports, and technical assistance, EPA measures the success of NYCDEP coordination with NYSDEC through the WECC (see below).

Program Implementation: The WWTP Inspection and Compliance Program objectives are measured by tracking the pace at which violations are verified and compliance is achieved, either through voluntary measures or through formal enforcement actions by the City or the State. The WECC strategy, described earlier, addresses compliance/enforcement issues for all the 106 SPDES surface water dischargers located in the Catskill, Delaware, and Croton watersheds. In addition, "circuit rider" technical assistance is implemented in accordance with established protocols in the DEC/DEP MOU. Compliance assistance coordination among NYCDEP and NYSDEC participants at the quarterly WECC forums has directly resulted in increased compliance over the past five years. WWTP owners have been generally appreciative of the "circuit rider" technical assistance provided by NYCDEP and NYSDEC to quickly troubleshoot operational problems and get facilities back into compliance before legal action becomes necessary. Since the inception of the WECC in July 1994, there has been continued improvement of the SPDES compliance status of all WWTPs located in the New York City watershed. The WECC institutionalized an aggressive compliance assistance and enforcement coordination program against SPDES violations. Total SNC, as defined by EPA, comprises both reporting and effluent discharge violations. By the end of 1999, the total universe of SNC violations has been reduced to a quarterly average of 8% from over 30% five years ago. Out of the total SNC, effluent discharge violations have been reduced to a quarterly average of 5% during 1999 from nearly 20% during 1995 (see Figure VIII.1).

Figure VIII.1 - New York City Watershed SNC



Key
SNC - Significant Non-Compliance
IELs - Interim Effluent Limits

All current SNC violations are being addressed through formal enforcement actions by NYSDEC and/or NYCDEP. Implementation of the NYSDEC "short-form" penalty order has dramatically reduced the number and frequency of delinquent reporting by facilities not previously required to submit DMRs. As a result, overdue DMRs have become a rare occurrence in the New York City watershed over the past year. Due to appropriate State and/or City enforcement follow-up to address violations by watershed SPDES dischargers, EPA has not had to initiate federal enforcement action since implementation of the WECC process.

Water Quality Evaluation: The primary mechanism for evaluation of the WWTP Inspection and Compliance Program will be through monitoring of treated wastewater in conformance with each WWTP's SPDES permit. As displayed in the above figure, there has been a dramatic improvement in overall compliance status with current permits which will most likely have a positive impact on the program's ability to meet water quality goals. Unequivocally, the reduction of the SNC violation rates with respect to discharge limits from over 20% to 5% since issuance of the December 1993 FAD is a positive mark towards meeting these goals.

v. Conclusions/Recommendations - From 1995 to 1999, "significant non-compliance" (SNC) violations were reduced from a quarterly average of over 30% to 8%. Effluent discharge violations

were reduced from 20% to 5%. All current SNC violations are being addressed through formal enforcement actions by NYSDEC and/or NYCDEP. This declining trend in SNC violation rates is a measure of the program's success to date. EPA considers 0% SNC to be an appropriate and achievable goal, as NYCDEP and NYSDEC continue to work together to implement this enhanced regulatory strategy in the watershed.

To further increase long-term WWTP compliance, EPA recommends that greater operation and maintenance (O&M) support be provided to small, owner-operated facilities such as restaurants, summer camps, and schools. These facilities do not always receive adequate O&M attention that is required to maintain compliance. Only during some NYCDEP or NYSDEC quarterly inspections are deficient O&M situations discovered and corrected. Some of these business owners have voiced concern that they lack wastewater treatment expertise. Where owner/operators do not obtain adequate training and certification, contract operations must be employed. We note that NYSDEC provides operator training and certification at regular intervals and has committed to work with NYCDEP to ensure that all WWTP operators are certified, watershed-wide. These efforts should focus on improving the operational status of small, privately-owned WWTPs.

B. WWTP SPDES Upgrade Program

i. Program Description and Objectives - There are two components to the SPDES Upgrade Program: (1) modification of original SPDES permits to reflect appropriate current (interim) effluent limitations and monitoring requirements where inadequacies exist (as determined by the Inspection and Compliance Program discussed above), and (2) financial assistance to WWTPs in the Catskill/Delaware watershed for equipment repair, upgrade or replacement to meet the conditions of their SPDES permits. It is important to note that the new interim permit requirements are more protective of water quality than the original permit requirements for many watershed WWTPs. In addition, NYCDEP has been working with NYSDEC to include final effluent limitations and monitoring requirements in the SPDES permit modifications beyond current SPDES requirements to reflect operation of advanced tertiary treatment measures required by the City's WR&R. The main objectives of this program are to help facilitate compliance with SPDES permits and to "upgrade" SPDES permits to include appropriate monitoring requirements.

ii. Program Assessment

FAD Compliance: During 1998, all final draft modified SPDES permits were issued to all permittees in accordance with FAD Task 312f-3. During the public notice period, NYCDEP met with NYSDEC, NYSDOH, and EPA to clarify permit changes and address specific concerns from WWTP owners. In accordance with FAD Task 312f-4, NYCDEP has been working with NYSDEC to issue final SPDES permits as soon as possible in accordance with the State Administrative Procedures Act (SAPA). Final modified SPDES permits for City-owned plants were the first to be issued since their

regulatory upgrades were completed in accordance with NYSDEC Consent Orders or SPDES permit schedules and the 1997 FAD, ahead of the 2002 deadline in the WR&R. During 1998, all other non-City-owned plants were issued draft modified SPDES permits containing interim (existing) effluent limits and final effluent limits to comply with the WR&R. NYSDEC began issuing final SPDES permits in accordance with SAPA during 1999. NYSDEC has reported that over 100 final SPDES permit modifications for east-of-Hudson and west-of-Hudson combined have been issued to date. See Table VIII.2 below for a status summary.

Table VIII.2 - SPDES Permit Modification Requirements

Activity	FAD Task	Deadline	Status
NYSDEC issues proposed draft SPDES permits	312f-3	4/97	completed by 8/97
NYSDEC issues final modified SPDES permits	312f-4	ASAP	ongoing (85% complete)

To address the second component of the SPDES Upgrade Program, NYCDEP has committed $5 million dollars through the Watershed MOA to repair or replace equipment that is not reliable or has ended its full useful life for Catskill/Delaware WWTPs. These funds are targeted for facilities which are not meeting their current interim SPDES permit requirements due to equipment/process limitations. Pursuant to the Watershed MOA, $400,000 of the $5 million is dedicated to perform collection system infiltration and inflow (I/I) reduction. To date, NYCDEP has expended approximately $260,000 of the $4.6 million towards SPDES upgrades at four WWTPs, with approximately $1.8 million in the pipeline for SPDES upgrade work to be performed in conjunction with the regulatory upgrade work. There are no specific mandates associated with this activity in the 1997 FAD; however, it is expected that NYCDEP will expend the remaining SPDES upgrade funds, including the $400,000 for I/I reduction, in accordance with the MOA and in conjunction with the regulatory upgrades, to ensure compliance and reliable operation is in place to meet final SPDES permit requirements.

***Program Implementation**:* Out of the 42 WWTPs in the Catskill/Delaware watershed, NYSDEC has issued 35 final SPDES permit modifications. Five WWTP owners (Golden Acres Farm & Ranch, Ron De Voo Restaurant, SEVA Institute, Camp Timber Lake, and Mountainside Restaurant) have challenged their final permits and are proceeding with hearings and one WWTP owner (Woodstock Percussion formerly EG&G Rotron, Inc.) has not been issued a final modified permit due to a recent change in ownership. The five facilities in pending status are required to comply with their original permits until the hearing process is concluded; then the final modified permits will be issued and become effective. We anticipate these remaining six SPDES permits in the Catskill/Delaware watershed to be

issued and become effective during 2000. NYCDEP is required to keep EPA regularly updated on the status in accordance with Task 312f-4.

To aid WWTP owners/operators in understanding their new, enhanced interim SPDES permit requirements, NYSDEC technical assistance staff, in consultation with NYCDEP and EPA, compiled a guidance manual, *The Plain English Guide for Testing & Reporting of Small Wastewater Systems.* The guidance manual is intended to help operators perform accurate sample monitoring and reporting on the facility's DMRs, where previous sampling and reporting was not required. It is anticipated that this will result in less monitoring and reporting errors and will increase confidence by owners and regulators that SPDES requirements are being consistently met.

Through expenditure of SPDES Upgrade Funds, equipment upgrades have been made at some facilities (e.g., Camp Loyaltown, Regis Hotel, Frog House Restaurant, and Ski Windham) to address recurring compliance problems at their WWTPs. Funding is provided as reimbursement following NYCDEP's approval of the completed work. Although no specified time frames to complete SPDES upgrades are contained in the FAD, the objective of this program is to expedite compliance through equipment upgrades. In fact, two SPDES upgrades (Camp Loyaltown and Regis Hotel) were initiated by NYCDEP under streamlined emergency review procedures. These two actions are discussed below in detail.

> ***Camp Loyaltown***: In late 1995, NYCDEP inspectors reported poor operating performance at Camp Loyaltown due to a failing subsurface sand filter system resulting in SNC for Biological Oxygen Demand and ammonia. NYCDEP required the owner to reconstruct the subsurface sand filter system by 1997. Some corrective work was completed but was inadequate to enable the facility to consistently meet its SPDES permit. By August 1997, NYCDEP initiated plans with the facility owner and New York State Environmental Facilities Corporation (NYSEFC) to perform an emergency SPDES upgrade to be completed prior to the camp's 1998 summer season. By October 1997, NYCDEP reported that the owner obtained an engineer to design the appropriate upgrade. With additional design modifications, construction of the new sand filter was completed by July 1998. Although the upgrade was performed in a reasonable timeframe once the problem was considered by NYCDEP to be an emergency (mid-1997), the problem should have received a higher level of oversight back in 1995 and corrected prior to the 1997 operating season.
>
> ***Regis Hotel***: In October 1998, after the summer operating season, NYCDEP inspectors determined that the subsurface sand filter at the facility had failed, resulting in fecal coliform breakthrough. By January 1999, NYCDEP reported that Regis Hotel had entered into an emergency SPDES upgrade contract and by April 1999, NYCDEP reported that corrective work was completed on schedule, prior to the 1999

summer season. In October 1999, NYCDEP reported that the sand filter had failed in August 1999, and that repairs were not completed in accordance with the SPDES upgrade contract. By December 1999, NYCDEP reported that the contractor agreed to complete the work and the facility owner agreed to hire a certified contract operator by February 2000. The contractor should have been subject to more thorough NYCDEP oversight to ensure completion of corrective work in accordance with the contract.

EPA supports NYCDEP's efforts to streamline SPDES upgrades of WWTPs with troublesome and long-standing compliance problems; however, better attention is necessary to ensure construction activities are performed appropriately. If a non-compliance situation is determined to be an "emergency," an expedited upgrade performed poorly defeats the objective of this effort. It is important to note that problems encountered during this program should serve as an early warning to problems that may be encountered (on a grander scale) during the construction phase of the WWTP Regulatory Upgrade Program. The two examples above suggest that substantial NYCDEP oversight may be necessary to ensure the program's success.

NYCDEP should consult with NYSDEC's Technical Assistance Group as intended by the circuit rider program through the WECC to ensure that compliance with SPDES permit requirements will be met after completion of corrective work.

Water Quality Evaluation: Appropriate enforcement mechanisms are important elements to achieving success of the program. First, new modified SPDES permits must be issued to include appropriate limits and monitoring requirements as soon as possible. (As EPA noted above, the newly modified interim [current] permit requirements for most WWTPs are more protective than the original permits.) Second, capital improvements to repair or replace failing or unreliable equipment to assure consistent compliance with SPDES permits must be performed in a timely and appropriate manner. Diligent pursuit of these actions by NYCDEP, in coordination with NYSDEC, will have a positive impact on water quality in the interim, prior to completion of full regulatory upgrades.

iii. Conclusions/Recommendations: The SPDES Upgrade Program has made significant progress towards addressing inadequately treated discharges from existing WWTPs in the short-term. Revised SPDES permits with additional self-monitoring requirements are consistent with water quality goals. **EPA recommends that the City continue to utilize the SPDES Upgrade Program to help maintain a high level of SPDES compliance through addressing "interim" problems until final regulatory upgrades are completed. EPA recommends that NYCDEP ensure that SPDES Upgrade Funds are made quickly available to resolve priority issues identified through the WECC process.**

EPA recommends "emergency" upgrades be streamlined and completed under strict supervision, and that NYSDEC's Technical Assistance Group be utilized to ensure that compliance with SPDES permit requirements will be met.

C. WWTP Regulatory Upgrade Program

i. Program Objective: The objective of the WWTP Regulatory Upgrade Program is to reduce microbial and nutrient loadings by performing process upgrades at all existing WWTPs in the New York City watershed with best available control technology (BACT) - namely microfiltration or an approved equivalent technology and phosphorus removal. The Program is managed by NYCDEP in conjunction with NYSEFC.

In accordance with the City's WR&R, EPA's FAD requires the completion of these upgrades no later than five years of the effective date of the City's WR&R, or May 2002. Special emphasis was initially placed on City-owned WWTPs, prior to promulgation of the City's WR&R.
Deadlines for the upgrades to these facilities are specified in NYSDEC's administrative consent orders or in the WWTPs' SPDES permits (and EPA's FAD), and are earlier than the schedule specified in the WR&R.

ii. Program Description: There are two main elements to the Regulatory Upgrade Program: (1) modification and issuance of SPDES permits to incorporate final water quality goals contained in the WR&R (pathogen and nutrient reduction); and (2) the performance of regulatory upgrades to current facility processes to meet pathogen and nutrient reduction requirements through installation of microfiltration or approved equivalent and phosphorus removal using BACT. NYCDEP has been working with NYSDEC in the issuance of draft modified SPDES permits to include additional monitoring and reporting requirements beyond current SPDES requirements for all WWTPs to reflect operation of advanced tertiary treatment upgrades required by the WR&R. Final SPDES permit requirements are currently in effect at all City-owned WWTPs. These same requirements will go into effect at all non-City owned plants six months from the date that NYCDEP certifies "functional completion" of the facility's regulatory upgrade (as required in the facility's Final Upgrade Plan). These requirements are as follows:

> *Giardia lamblia* Cysts - Facility must be capable of achieving 99.9% (3-log) removal and/or inactivation of *Giardia lamblia* cysts. Capability shall be demonstrated by maintaining the turbidity and chlorine levels specified and operating the microfiltration unit or approved equivalent technology and the disinfection system on a continuous basis, in accordance with the provisions set forth in the WWTP's Operation & Maintenance Manual.

Enteric Viruses - Facility must be capable of achieving 99.99% (4-log) removal/inactivation of enteric viruses. Capability shall be demonstrated as stated above for *Giardia lamblia* cysts.

Turbidity - The turbidity levels shall be maintained at less than or equal to 0.5 NTU in 95% of the measurements taken each month and an instantaneous maximum of 5.0 NTU. The minimum monitoring requirements shall consist of a continuous sample recorder after microfiltration or equivalent technology.

Chlorine Residual - When chlorine is used for disinfection, a minimum residual of 0.2 mg/l shall be maintained in the chlorine contact tank prior to dechlorination. The minimum monitoring requirements shall consist of one grab sample per day at the chlorine contact tank prior to dechlorination.

Phosphorus Removal - WWTPs shall provide phosphorus removal using BACT to meet SPDES final effluent limitations for total phosphorus according to the following requirements:

SPDES Permitted Total Flow (gallons per day)	Total Phosphorus Limit (mg/l)
≤50,000	1.0
>50,000 and <500,000	0.5
≥500,000	0.2

iii. Program Assessment

FAD Compliance - Since EPA's January 1993 FAD, the City has committed to upgrade its six WWTPs in the Catskill/Delaware watershed (Grahamsville, Margaretville, Pine Hill, Grand Gorge, Tannersville, and Chichester) with the BACT (i.e., microfiltration or approved equivalent and phosphorus removal) to control pathogens, viruses, and phosphorus loadings. (EPA notes that Chichester is a SPDES subsurface discharger and is not required by the WR&R to be equipped with microfiltration or approved equivalent technology.) The six plants are also under either a NYSDEC administrative consent order or WWTP SPDES permit schedule to complete the upgrades ahead of the five year schedule contained in the May 1997 WR&R. For consistency, EPA included the NYSDEC ordered dates in the 1997 FAD (FAD Task 312b-1). The last City upgrade (Margaretville) was completed in August 1998. In March 1999 the Margaretville facility met final SPDES permit requirements in accordance with the NYSDEC Order and FAD Task 312b-1 of the 1997 FAD. See Table VIII.3 for the upgrade timeframes of all City-owned WWTPs.

Table VIII.3 - Upgrade Status of City-owned WWTPs

WWTP	Complete Construction	Comply w/ SPDES Final Effluent Limits	Status
Chichester	6/30/96	10/31/96	Complete
Grahamsville	3/31/97	9/30/97	Complete
Tannersville	5/30/97	8/31/98	Complete
Grand Gorge	8/31/97	8/31/98	Complete
Pine Hill	8/1/98	12/1/98	Complete
Margaretville	8/31/98	3/31/99	Complete

The FAD compliance status of the remaining 34 non-City-owned WWTPs is shown in Table VIII.4. We note that two State-owned facilities have established intermunicipal agreements with the City for their upgrades in accordance with the MOA. In addition, all WWTP owners have selected engineers and submitted engineering proposals to NYSEFC and NYCDEP for approval after securing compliance with the first two FAD compliance dates.

Table VIII.4 - Upgrade Status of Non-City owned WWTPs

FAD Task	Description	Deadline	Status
312f-2	Summit signed NYSEFC/WWTP owner negotiated contracts to NYCDEP	5/98	Complete
312n-1	Secure NYCDEP approval of Upgrade Contracts and project schedules	11/98	Complete
312o	Complete regulatory upgrades to comply with the WR&R	5/02	Ongoing

There are no FAD Task deadlines between November 1998 (312n-1) and the final upgrade completion date of May 2002 (312o). The following section ("Program Implementation") includes a discussion of the City's progress in meeting the May 2002 deadline.

Program Implementation and Progress Analysis - As stated above, construction has been completed at all six NYC-owned WWTPs in compliance with the WR&R. These facilities are meeting

Final Effluent Limits in accordance with the schedules contained in NYSDEC administrative consent orders or their SPDES permits and the 1997 FAD. A final EPA inspection took place in April 1999 which verified full compliance with FAD Task 312b-1.

In accordance with the 1997 FAD, Watershed MOA, and WR&R, the City obtained signed NYSEFC/WWTP owner-negotiated upgrade contract agreements by May 1998, and approved upgrade contracts and project schedules by November 1998, for non-NYC owned WWTPs. The upgrade contracts between NYSEFC and the WWTP owner include a generic Schedule of Work ("contract upgrade schedule") which shows specific milestones to be met leading up to the May 2002 upgrade completion date. There are no specific milestone dates in the schedule; rather a number of sequential activities (Tasks "M1" through "M10") are triggered by a Notice to Commence Work from NYCDEP to the WWTP owner. Each activity performed by the WWTP owner is allotted a specific timeframe for completion. There are no required timeframes for document reviews by NYSEFC or NYCDEP. To properly track the progress of the program, an estimated timeline was developed as a baseline to determine when particular tasks would have to be completed in order to meet the final May 2002 project completion date. An example project timeline is presented in Table VIII.5. To conform to the May 2002 deadline, the timeline is extremely tight in that it assumes short document review turn-around times by NYCDEP and NYSEFC. It also assumes that construction will progress at a normal pace through the
off-season winter months. In order to comply with FAD Task 312o and the WR&R, Task M9, "Submit Functional Completion Certification" must be completed by May 1, 2002. Other assumptions are listed in Table VIII.5.

Table VIII.5 - Table Showing Milestones in Upgrade Contracts & Estimated Completion Dates Necessary to Meet the May 1, 2002 Completion Date

Task	Milestone/Description	Activity Duration	Estimated Completion Date
--	Notice to Commence Work		2/1/99
M1	Select Engineer/Distribute RFP	2 months from Notice to Commence Work	4/1/99
M2	Receive Engineer Proposals and Submit to NYSEFC	2 months from WWTP owner's distribution of RFP (then assume 2 months to approve proposal)	6/1/99
M3	Submit WWTP Owner/Engineer Contract to NYSEFC	1 month from NYCDEP's approval of selected engineer's proposal (then assume authorization to execute contract in 1 month)	9/1/99

Task	Milestone/Description	Activity Duration	Estimated Completion Date
M4	Submit Conceptual Upgrade Plan (CUP)	4 months from date NYSEFC authorizes WWTP to execute engineer's contract (then assume 2 month NYCDEP review/approval of CUP)	2/1/00
M5	Submit Facility Plan to NYSEFC	3 months from receipt of NYCDEP approval of CUP and authorization to proceed from NYSEFC (then assume 1 month NYCDEP review/approval)	7/1/00
M6	Submit Preliminary Upgrade Plan (PUP)	4 months from receipt of NYCDEP approval of Facility Plan (then assume 2 month regulatory review to approval)	12/1/00
M7	Submit Approvable Final Upgrade Plan (FUP)	1 month from receipt of NYCDEP approval of PUP (then assume 1 month regulatory review to Notice to Proceed)	3/1/01
M8	Submit Owner/Contractor Agreement	2 months from receipt of NYSEFC Notice to Proceed with Bid Solicitation	6/1/01
--	Written approval of contract and of contractor's business integrity from NYCDEP, submit insurance docs., performance bonds, receive Notice to Proceed with Execution of Contracts	No required timeframe - assume 2 months for this process	8/1/01
M9	**Submit Functional Completion Certification**	**9 months from Notice to Proceed with Execution of Contract & construction**	**5/1/02**
M10	Submit Construction Close-out documents	30 business days from NYCDEP's authorization to commence startup and performance and to proceed with project close-out	

The target milestone dates in Table VIII.5 are presented to show the schedule against which each facility will be gauged to determine its ability to comply with the May 2002 completion date. Table VIII.6 presents the current status (as of April 28, 2000) of all 34 WWTPs in the Catskill/Delaware watershed that are scheduled to be upgraded. Table VIII.6 indicates that only two facilities are progressing consistent with the schedule in Table VIII.5 to potentially meet the May 2002 upgrade completion date.

Table VIII.6 - Current Upgrade Status of the 34 Cat/Del WWTPs

Task	Hypothetical Date Which Estimates When Task Must be Completed to Meet the May 2002 Upgrade Completion Date (from **Table VIII.5**)	**Number of WWTP Facilities That Have Met the Estimated Task Date**	Number of Facilities That Have Completed Task by 4/28/00
M1	4/1/99	34	34
M2	6/1/99	32	34
M3	9/1/99	8	27
M4	**2/1/00**	**2**	**11**
M5	7/1/00		0
M6	12/1/00		0
M7	3/1/01		0
M8	6/1/01		0
M9	5/1/02		0
M10			0

In mid-1998, EPA began to raise concerns to NYCDEP regarding delays in implementing the Regulatory Upgrade Program. The Watershed MOA contained fairly comprehensive model contracts that were to be used to start the upgrade process. Unfortunately, the model contracts were re-negotiated and modified substantially over the next year resulting in the City barely obtaining signed contracts by May 1, 1998. Notices to Commence Work, which trigger the start of Task M1, were delayed four to five months in order to obtain insurance verification and other documentation required by the City. These preliminary administrative tasks should have been completed during the model

contract negotiations. These prolonged contractual negotiations and delays on other administrative requirements resulted in a compliance schedule that, by early 1999, was unlikely to be met.

Subsequent to the issuance of Notices to Commence Work, excessive review/approval turnaround times of five to nine months or longer for some facilities have further delayed implementation of the program. To illustrate, EPA records indicate that the Village of Hobart received a Notice to Commence Work on August 13, 1998 and completed selection of engineer(s)/distribution of Request for Proposals (Task M1) on September 17, 1998. Two engineer's proposals were submitted to NYSEFC (Task M2) on November 27, 1998. Comments to those two proposals were provided by NYCDEP March 17, 1999, indicating a four month NYCDEP/NYSEFC review on first round engineering proposals. A final engineering proposal for the Village of Hobart WWTP was approved by NYCDEP on August 13, 1999. The Task M2 review and approval process took nine months to complete. See Table VIII.7 for other examples of delays at the Task M2 review stage (highlighted in the table) and project status as of April 28, 2000.

Table VIII.7 - Examples of Project Delays at the Task M2 Stage

WWTP	Village of Walton	Village of Stamford	Roxbury Run
Notice to Commence Work	8/13/98	8/17/98	8/13/98
Select Engineer/Distri-bute Request for Proposals (M1)	8/24/98	9/21/98	9/23/98
Submit engineers proposals to NYSEFC (M2)	10/14/98	11/20/98	12/1/98
Engineer's proposal approved by NYCDEP	3/22/00	4/29/99	10/7/99
Submitted owner-engineer contract to NYSEFC (M3)	4/18/00	6/25/99	10/22/99
NYSEFC authorization to execute owner-engineer contract	Not completed.	8/2/99	11/29/99

Pre-CUP meeting	Not completed.	9/16/99	1/10/00
Draft CUP submitted	Not completed.	1/26/00	4/17/00
CUP approved	Not completed.	2/10/00	Not completed.

The examples in Table VIII.7 show engineering proposals (Task M2) taking from five to over twelve months to be reviewed and approved by NYCDEP and NYSEFC. As of April 28, 2000, five WWTPs still have not secured NYCDEP Task M2 approvals. These proposals were originally submitted between late 1998 and early 1999; thus, they have been in the review pipeline for over twelve months. The Village of Walton WWTP, which at 1.17 MGD is the largest SPDES discharger in the Catskill/Delaware watershed, took 17 months to secure its NYCDEP Task M2 approval.

We note that the Task M2 review, discussed above, is the first of at least seven separate sequential NYCDEP approvals or NYSEFC notices/authorizations that must be obtained prior to the commencement of construction. In order for the WWTP upgrades to be completed by May 2002, these review/approval stages can take no longer than one to two months each. The first stage has taken from five to over twelve months.

EPA raised this concern again in a September 21, 1999 letter to NYCDEP which asked for (1) a detailed analysis on how it intends to meet the May 2002 construction completion date (with an upgrade schedule as an example); (2) the assumptions going into its analysis; and (3) specific streamlining procedures that will mitigate an already protracted schedule. A January 3, 2000 response from NYCDEP included steps that NYSEFC and NYCDEP are taking to streamline and accelerate the program. It also included a proposed upgrade schedule to comply with the May 2002 date. The City's proposed schedule included similar assumptions contained in the hypothetical schedule example - see Table VIII.5. As of the date the letter was submitted, January 3, 2000, the City was already far behind this schedule. Some of NYCDEP's proposed streamlining measures include:

- Engineers with unapproved engineering proposals (Task M2) are being asked to submit draft owner/engineer contracts (Task M3) with revised proposals for a pre-screening review. As a result, NYCDEP expects that preparation of owner/engineer contracts will be 30 days or less for some WWTPs.

- NYCDEP and NYSEFC have developed informational bulletins on preparation of CUPs including a model CUP and holding pre-CUP meetings to clarify the details necessary for an approvable CUP. DEP expects this will shorten preparation time of the CUP from 120 days to approximately 60 days.

- NYCDEP and NYSEFC are working to shorten internal turnaround times for review/approval of submitted documents.

- NYCDEP and NYSEFC, is in the process of hiring private consulting engineers to assist in the review and approval of the facility plans and other subsequent engineering documents.

The hiring of additional engineers was first discussed with EPA in early fall 1999. As of April 2000, we are not aware that any of these hirings are in place. Unfortunately, based on the progress to date, the City will not meet its obligation in accordance with FAD Task 312o of the 1997 FAD at this mid-course point. EPA acknowledges NYCDEP's commitment to work with the NYSEFC and WWTP owners to advance the upgrades to completion as soon as possible; but unless there is a substantial addition of personnel resources and a strong and continuing commitment to streamline the upgrade schedules, the program will fall further behind.

EPA is also concerned that delays in the Regulatory Upgrade Program may negatively impact progress in the New Sewage Treatment Infrastructure Program. According to information submitted to EPA by NYCDEP, seven WWTP owners have reported interest in decommissioning their plants, consisting of approximately 135,000 gpd total aggregate SPDES flow, and connecting to new municipal WWTPs constructed under the New Sewage Treatment Infrastructure Program. There are also existing small private- or State-owned WWTPs located within the service area of existing municipal plants. One WWTP (Belleayre Ski Center) has already connected to the existing Pine Hill WWTP and one WWTP (Ultra Dairy, Inc.) has expressed interest in connecting to the existing Village of Delhi WWTP. See Table VIII.8 for a summary status.

Table VIII.8 - Status of WWTPs Requesting Hookup to Existing or New Sewage Treatment Infrastructure Program Municipal Facilities

Participating Community	Existing WWTP interested in hookup to New or Existing Municipal Facilities	Status
Hunter	Forester Motor Lodge Hunter Highlands Camp Loyaltown Whistletree Development	all pending
Fleischmanns	Regis Hotel	pending
Windam/Hensonville	Thompson House Frog House Restaurant	all pending
NYC-Pine Hill WWTP	Belleayre Ski Center	connected 12/99

Delhi WWTP	Ultra Dairy, Inc.	pending

NYCDEP requires these WWTP owners to proceed "dual-track" through the design stage while it awaits community decisions to decommission and connect to the new municipal facility constructed under the new infrastructure program. Design is proceeding so that no time is lost to upgrade of the existing WWTP should a community disapprove. EPA is concerned that the slow progress of the upgrades may actually impede progress of the new infrastructure program. See Section VII on the New Sewage Treatment Infrastructure Program for a more detailed overview and assessment of the issues.

Water Quality Evaluation*:* Completion of the Regulatory Upgrade Program is expected to have a positive affect on water quality by virtually eliminating pathogen and nutrient contamination to the water supply from WWTPs. We have already begun to see the positive effects of the Upgrade Program on effluent quality through monitoring data at City-owned WWTPs. These recently upgraded facilities are complying with treatment requirements of their SPDES permits, including pathogen reduction and phosphorus removal. Substantial reductions in coliform bacteria, *Giardia* and *Cryptosporidium* have been documented at Grahamsville and Tannersville. For example, the Tannersville WWTP, which recently completed its regulatory upgrade, has reported a reduction in fecal coliform discharge from 1200/100 ml (1996 pre-upgrade annual monthly average) to 9/100 ml (1999 post-upgrade annual monthly average).

With respect to other pathogens, for the past seven years the City has been analyzing samples from seven WWTPs (Stamford, Hobart, Delhi, Walton, Brewster, Tannersville, and Grahamsville) for *Giardia* and *Cryptosporidium* and has been submitting the results to EPA (FAD Task 308e-1). Out of 505 samples taken from the effluent of the seven WWTPs, *Giardia* cysts were detected in 45.2 % of the samples (5.2% confirmed) and *Cryptosporidium* cysts were detected in 11.5% of the samples (1.8% confirmed). With the recent completion of regulatory upgrades at the Grahamsville and Tannersville WWTPs, NYCDEP has been reporting a decline in concentration of *Giardia* and *Cryptosporidium* (oo)cysts at these facilities to nondetectable levels.

With respect to in-stream water quality impacts, the City's "Addendum E report" submitted in May 1999 discusses downstream impacts of select WWTPs in the Catskill/Delaware Watershed (e.g., Tannersville, Grand Gorge, Pine Hill, Margaretville, Stamford, Hobart, S. Kortright, Delhi, and Walton). The report describes locations where in-stream ambient water quality standards (AWQS) are exceeded and lists likely sources of the pollution. The following are the AWQS used to evaluate stream monitoring data:

Parameter	Standard Value
pH	$6.5 \leq pH \leq 8.5$
fecal coliform bacteria	$\leq$ 200/100 ml

total coliform bacteria	$\leq$ 2400/100 ml
total phosphorus	$\leq$ 50 ug/l
dissolved oxygen	$\geq$ 6 mg/l
ammonia (NH_3-N)	$\leq$ 2 mg/l
nitrates (NO_3-N)	$\leq$ 10 mg/l

In the latest reporting period, January 1, 1998 through June 30, 1998, the City-owned Tannersville and Grand Gorge WWTPs were eliminated as potential sources of coliform bacteria and phosphorus. Improvements were also seen at the Pine Hill facility. The remaining non-City owned WWTPs and the City-owned Margaretville WWTP (upgrade completed after the 6/30/98 reporting period) were listed as likely sources of pollution causing exceedances of downstream AWQS.

To illustrate the potential improvement to in-stream AWQS as a result of the regulatory upgrades for these WWTPs, see Table VIII.9, which compares NYCDEP calculated pre-upgrade phosphorus loads and post-upgrade phosphorus loads allowed under the WR&R and final modified SPDES permits. The table indicates that all WWTP upgrades will result in a reduction of phosphorus loadings to their discharge streams.

Table VIII.9 - Estimated Phosphorus Reductions at Select WWTPs

Facility Name	SPDES Permit Flow (gpd)	Actual Pre-upgrade Phosphorus Load (kg/yr)[1]	Final SPDES Permit Phosphorus Limit (mg/l)	Final Permit Post-upgrade Phosphorus Load (kg/yr)[2]	**Estimated Phosphorus Reduction (kg/yr)**
Delhi	515000	1,270	0.2	143	**1127**
Hobart	160,000	202	0.5	111	**91**
S. Kortright	20,000	78	1.0	28	**50**
Stamford	500,000	551	0.2	139	**424**
Walton	1,170,000	5,175	0.2	325	**4850**
Pine Hill	500,000	117	0.2	139	**0** [3]
Grand Gorge	500,000	173	0.2	139	**34**
Tannersville	800,000	480	0.2	222	**258**
Margaretville	400,000	547	0.5	277	**270**

[1] Phosphorus load calculated from NYCDEP sampled effluent flow and phosphorus concentration data during 1996.

[2] Permitted (allowable) phosphorus load calculated from effluent flow and phosphorus concentration limits contained in final SPDES permits.

[3] The Pine Hill WWTP has been operating at 25% of its capacity (500,000 gpd permitted flow) on average. The post-upgrade phosphorus load is calculated using SPDES permitted (full capacity) flow.

Continued compliance with SPDES requirements and the upgrade of all remaining WWTPs should result in long-term water quality benefits to the receiving streams. Compliance will be measured through SPDES permit monitoring requirements and NYCDEP's monitoring program. We anticipate that these improvements will be reflected in future "Addendum E" reports. EPA will put special emphasis on SPDES performance and compliance at the City's WWTPs as the basis for evaluating short-term water quality benefits for the remainder of the 1997 FAD.

iv. Conclusions/Recommendations

The Wastewater Treatment Plant Upgrade Program is a key component of the FAD. Based on information provided to date, the City will not meet its obligation to complete all non-City-owned WWTP upgrades in accordance with the 1997 FAD, WR&R and the Watershed MOA. EPA has met on several occasions with the NYSDEC, NYCDEP, NYSDOH, and others on the delays and actions which could be taken to streamline review/approval activities. **EPA strongly recommends that NYCDEP immediately accelerate completion of the Wastewater Treatment Plant Upgrade Program. The City's commitment and ability to complete this Program expeditiously will be a critical factor in determining the future of filtration avoidance. To that end, EPA requests that the City submit an action plan within 60 days which details actions the City will take to get the program back on track.**

The City has completed the upgrades of all City-owned WWTPs within the timeframes specified in the FAD. With these upgrades, approximately 40% of the total permitted WWTP flow in the Catskill/Delaware watershed is now subject to advanced tertiary treatment (microfiltration) requirements. **EPA recommends that NYCDEP begin to review and revise (as necessary) operation and maintenance procedures to reflect "lessons learned"at the City-owned WWTPs.** Enhancements to operation and maintenance procedures which reflect the City's operating experience at these relatively large facilities will greatly benefit non-City owned WWTP owners/operators as their regulatory upgrades are completed.

IX. Geographic Information System Program

1. Introduction - Program Objectives

The New York City Department of Environmental Protection (NYCDEP) collects a large amount of data to support a number of watershed programs. In order to facilitate the effective use of these data, the City has developed a Geographic Information System (GIS). GIS is a computer system consisting of hardware, software, data and users, that is capable of assembling, storing, manipulating, and displaying geographically referenced information. GIS is a useful tool for characterizing the spatial relationships of the many features of the New York City watershed. The objective of the GIS Program is to use this "tool" as effectively as possible to support the many elements of NYCDEP's watershed protection program.

2. Background

EPA's first Filtration Avoidance Determination (FAD - January 1993) contained a requirement that NYCDEP submit a plan for establishing a GIS. The City submitted its proposal in March 1993 submittal "10h." The proposal outlined a plan to couple GIS with water quality database development, and water quality models to support its growing watershed protection program. In particular it noted that GIS is needed to facilitate the following:

- Analysis and evaluation of environmental impact of development in the watershed;
- Support of water quality models to address specific watershed problems;
- Accurate evaluation and enforcement of the City's Watershed Rules and Regulations (then proposed);
- Identification of critical parcels for land acquisition;
- Assistance in the formulation of watershed policy and water quality management strategies; and
- Presentation of information on water quality programs to the public.

In the mid 1990s, NYCDEP supported the GIS effort through substantial purchases of GIS hardware and software as well as database development.

3. Program Assessment

A. FAD Task Compliance

In accordance with FAD Task 302b-1, the City reports quarterly on the status of its GIS Program. The information supplied provides a good overview of NYCDEP's GIS database development (through data acquisition/management), GIS "projects" and GIS library. The project descriptions are particularly useful in that they provide a sense of how the GIS is being utilized to support watershed protection programs.

B. GIS Implementation

The City is using GIS to support a number of watershed protection programs. It is currently refining reservoir boundaries for more accurate application of the Watershed Rules and Regulations. It has also begun to integrate hydrologic data and stream survey information into a database search engine that will help in its implementation of the Stream Management Program. Importantly, NYCDEP is using GIS to ensure that prioritized septic systems are being addressed either through the Septic Rehabilitation/Replacement Program or through the Sewer Extension Program. GIS is also being used to target eligible land for acquisition through the City's ability to query parcel data by land use. As the City begins to solicit more and more land in Priority 3 and 4 areas, GIS, as a tool for targeting solicitation, will become very important (see Land Acquisition Section). The Watershed Agricultural Council, in conjunction with the City, plans to use NYCDEP's GIS to identify priority areas for riparian forest buffers under the Conservation Reserve Enhancement Program. The City continues to add data layers (e.g., more accurate digital parcel data, orthophoto quadrangles, monitoring sites) to its GIS library to support this and other watershed protection activities.

An effective GIS program has also allowed NYCDEP to be very responsive to special projects and requests. EPA has requested multiple data layer maps on several instances and the City has been able to produce them quickly and accurately.

4. Recommendations

GIS is a useful tool for characterizing the spatial relationships of the many features of the New York City watershed such as: (1) location of pollution sources, (2) land uses, (3) water quality data, (4) trends in population and development, (5) soil and geologic features, (5) infrastructure, and (6) locations of "best management practices." We anticipate that NYCDEP's interface among its databases, GIS and terrestrial/hydrologic models will become more sophisticated as its watershed protection program continues. **EPA recommends that the City continue to enhance, refine, and add data layers to improve application of GIS in the watershed. In addition, as these "systems" become more complex and data-rich, we recommend that NYCDEP continue to find ways to use GIS to present this information in an understandable intuitive format to EPA and other interested parties**.

The use of the GIS to facilitate trend analysis will become critical as the City shifts its focus from program implementation to program evaluation, analysis, and modification. **EPA recommends that the City begin to develop a long-term plan on how it intends to utilize GIS for trend analysis, modeling, information dissemination and watershed protection/remediation program support in the future.**

X. Multi-Tiered Water Quality Modeling Program

1. Objectives

As part of its Multi-Tiered Water Quality Modeling Program, NYCDEP is developing several sophisticated models for use in the Catskill/Delaware watershed. The modeling effort has multiple objectives that, if successful, will be able to integrate a number of watershed protection programs and strategies. The Modeling Program should allow the City to:

- Estimate non-point source loadings of nutrients and sediments;
- Estimate hydrologic inputs to the reservoirs;
- Evaluate watershed management scenarios;
- Evaluate remediation activities;
- Improve management of the quantity and quality of water through water treatment and operational decisions;
- Refine monitoring efforts to improve model extrapolations and interpretations; and
- Support the development of Total Maximum Daily Loads (TMDLs).

By accurately predicting reservoir behavior as a function of land use activities, the City will be able to tailor non-point source management programs for each reservoir and predict how various remediation strategies will improve reservoir water quality. This work will support the TMDL program and provide a mechanism for evaluating water quality impacts from new development, new regulations and policies, and new technologies. Ultimately, the use of terrestrial, reservoir and network models will enable the City to depict water quality changes to the entire watershed based on specific pollutant inputs and selected remediation/protection alternatives.

2. Background

In 1994, EPA required NYCDEP to submit a plan and schedule for development of a watershed wide hydrologic/water quality model to (1) assess the potential impact of a full range of pollution sources in a

number of land use categories, (2) be compatible with modeling efforts in individual reservoirs, and (3) be useable for making reservoir/water system management decisions (FAD Task 303a).

The multi-tiered modeling system that the City proposed consists of two components, terrestrial and reservoir models. The **terrestrial** models predict landside (point and non-point) loadings as a function of watershed and sub-watershed geography and meteorology. NYCDEP selected the Generalized Watershed Loading Model (GWLF), a numerical model, which includes a water quality modeling component and a hydrologic modeling component. GWLF was selected because it:

- simulates climatic and hydrologic variability,
- incorporates empirical methods to calculate sediment erosion and surface runoff,
- allows for the separate evaluation and calibration of the hydrologic component,
- uses the data available for the watershed at the spatial and temporal scales for which the model was originally meant to be applied.

Reservoir models predict in-lake concentrations as a function of landside and atmospheric loadings, reservoir physiography and meteorology. The reservoir models include hydrothermal and eutrophication (also described as "water quality" and "nutrient-phytoplankton") sub-models. Both one and two-dimensional eutrophication models have been developed for the Cannonsville Reservoir and applied to the remaining reservoirs west-of-Hudson. The hydrothermal models (one and two-dimensional) were developed in order to provide the heat and mass balance framework necessary to run the eutrophication models. NYCDEP will use the one-dimensional hydrothermal and water quality models linked with GWLF to describe reservoir behavior, including eutrophication, due to nutrient and other constituent inputs. The hydrothermal and eutrophication models were designed to predict the following parameters, each of which help define the trophic status of the reservoirs:

- stratification characteristics (hydrothermal),
- temperature variations (hydrothermal),
- chlorophyll (nutrient-phytoplankton),
- zooplankton (nutrient-phytoplankton),
- soluble reactive P (SRP) (nutrient-phytoplankton),
- dissolved organic P (nutrient-phytoplankton),
- available non-living particulate P (nutrient-phytoplankton),
- unavailable non-living particulate P (nutrient-phytoplankton),
- ammonia, nitrate plus nitrite (nutrient-phytoplankton),
- dissolved organic N (nutrient-phytoplankton),
- zooplankton (nutrient-phytoplankton),
- non-living particulate N (nutrient-phytoplankton) and
- dissolved oxygen (nutrient-phytoplankton).

Through the mid-1990s, each of the models was developed, calibrated and verified for use in the Cannonsville Reservoir. The objective was to use the information gained through Cannonsville model development to set-up, assess, calibrate and verify models for the remaining Catskill/Delaware reservoirs. If model assessment indicated further model development or data collection was necessary, EPA's FAD required NYCDEP to identify the needs and a time frame for completion. (The Kensico Reservoir was modeled separately and is discussed in Chapter V.)

Model development, and later model calibration and verification, require extensive data collection. In 1994, NYCDEP proposed a schedule for a multi-year program to obtain data on soils, topography, land use, bathymetry, flow and temperature to support this effort. The installation of meteorological stations was also required. Initially, NYCDEP was required to incorporate pathogen loading data into the terrestrial models. However, there is a major informational gap on pathogens (e.g., sources, occurrence, density, survivability, infectivity and transport), and despite New York City's contributions toward advancing the knowledge base regarding pathogens, it was determined that this modeling initiative was not yet feasible. NYCDEP has agreed to support the basic research necessary to develop predictive models for pathogen loading.

3. Program Assessment

The assessment of the City's Multi-Tiered Water Quality Modeling Program is divided into two components: Terrestrial Models and Reservoir Models.

A. Terrestrial Models

i. FAD Compliance - The December 1994 FAD required calibration and verification of the GWLF (terrestrial) model for the Cannonsville Reservoir by December 1996. The 1997 FAD includes several steps for completing the terrestrial model for each of the other Catskill/Delaware reservoir basins. The set-up of GWLF models was required by March 1997 and model assessment was due by June 1997. Calibration and verification of the GWLF models for the remaining Catskill/Delaware Reservoirs was required by January 1998. To date, all FAD milestone dates have been met. The assessment indicated that further model development was necessary. In accordance with the FAD, in January, 1998 the City identified additional modeling needs and a timeframe for their completion. The FAD also requires NYCDEP to continue pathogen research necessary to develop predictive models of pathogen loading. NYCDEP reports on the progress of this research annually.

ii. Implementation Discussion and Assessment - By 1995, extensive amounts of data had been collected for the Cannonsville basin terrestrial model. Soil parameters were obtained from the Natural Resource Conservation Service (NRCS) State Soil Survey Geographic Database (SSURGO), and land use classification was completed based on Thematic Mapper satellite imagery. Daily air

temperature and precipitation data were obtained from National Climate Data Center meteorological stations located within and adjacent to the watershed. Measured discharges at 20 USGS gauge stations throughout the watershed were collected to verify the hydrologic component of the model. Storm event nutrient and sediment loading data from four sites in the Cannonsville basin were collected to verify the water quality component of the model.

The GWLF model was re-coded into the Vensim Visual Modeling Environment to utilize its calibration, verification, sensitivity analysis and visualization tools. Because of this change, the model was re-applied to the Cannonsville basin. The modified GWLF models were set-up for the west-of Hudson basins, including Cannonsville, by creating the necessary data and parameter input files, running the model and demonstrating that the model results were plausible.

Model Assessment

The June 1997 assessment of the GWLF (conducted by NYCDEP in accordance with FAD Task 303k) examined the suitability of the input data, model coefficients and performance. The assessment also identified the steps necessary to both maximize the utility of the GWLF model and link it with the reservoir models. Eight basins with USGS gauging stations were selected to assess the sensitivity and error analysis of the hydrologic sub-model. Two basins (upstream of water quality monitoring stations) were used to assess the water quality sub-model.

The hydrologic model was most sensitive to the precipitation correction factor. Seasonal trends were well represented; however, the error in a specific month could be significant. The model tended to underestimate peak summer flows. Improvements in the model's performance could be achieved by including snowpack and snowmelt components accounting for temperature differences and basin specific precipitation correction factors.

The assessment of the water quality model on the sub-basin scale concluded that several areas of the model needed improvement. A representative coefficient for nitrogen needed to be determined. The model's ability to predict sediment yield was very sensitive to changes in precipitation, leading NYCDEP to recognize that GWLF's method for estimating sediment needed further research. Seasonal patterns and total annual estimates of dissolved phosphorus were acceptable; however, values were underestimated during low flow months. GWLF did not predict observed nutrient values on the farm scale. Overall, NYCDEP was satisfied that GWLF could meet its objectives with additional work. The model can predict long-term loading rates and seasonal trends in nutrients. Improvements in the input data, loading coefficients and model framework were needed to improve overall performance.

By January 1998, several modifications were made to the sediment yield algorithm of GWLF (FAD Task 303l). The method for calculating the annual sediment load was revised, along with the method

for calculating the monthly transport capacity of streamflow. The sediment delivery ratio was also upgraded. These revisions significantly improved the model's performance. Task 303l describes the calibration and verification methods for the hydrologic and water quality models. Model efficiencies for simulating streamflow and dissolved nutrients were at or above 0.80. Acceptable model efficiencies were achieved for simulating sediment yield (0.68) and particulate phosphorus (0.73). Despite acceptable model efficiencies, the document included the following recommendations to increase the model's performance as a management tool:

- Validate the models with water quality data for watersheds other than Cannonsville to increase confidence in using the model as a management tool in those watersheds;
- Reduce uncertainty in climatic data and hydrologic sub-model estimates to improve predictions;
- Improve estimate of streamflow during summer baseflow;
- Determine how land cover types affect dissolve phosphorus concentrations in groundwater;
- Improve phosphorus concentration coefficients by using actual data on soil phosphorus levels and manure spreading practices;
- Incorporate a peak rainfall and peak flow function to better estimate sediment and nutrient loads during extreme events; and
- Investigate adding a channel erosion function.

Throughout 1999 work continued on data development and model refinement to address the recommendations. Improvements made included (1) basin specific data for calibration in the Pepacton watershed, (2) land use/land cover refinement, (3) addition of urban sediment and groundwater dissolved nutrient estimations, (4) refinement of the sediment delivery ratio and (5) development of an Arcview tool for generating input files. The GWLF model has now been calibrated for the Cannonsville and Pepacton watersheds using the improved data. NYCDEP expects to complete calibration in the Neversink, Ashokan, Schoharie and Rondout watersheds in 2000.

NYCDEP continues to conduct monitoring to contribute data necessary to improve the use of GWLF which is data intensive and requires numerous parameter inputs. NYCDEP has begun to collect storm event samples in several major tributaries located outside the Cannonsville basin to increase confidence in using the model as a management tool in those watersheds. Additional meteorological stations have been installed and high resolution elevation data to improve the snowmelt model is being collected. The Town Brook Study is being initiated and will contribute data to evaluate the phosphorus export from agricultural areas of the watershed. Additionally, NYSDEC and NYCDEP are cooperating on a SDWA-funded Meteorological Study to develop a method of storing, processing and analyzing the meteorological data used for NYCDEP's hydrologic and water quality models.

Model Applications

To date, the GWLF model has been used as part of the City's Phase II TMDL analysis to calculate annual dissolved and particulate loads to each of the west-of-Hudson reservoirs for years 1992 through 1996.

iii. Conclusions/Recommendations

A primary objective of GWLF model development is to enhance its capabilities as a management tool for evaluating the effectiveness of watershed protection and remediation programs in the New York City watershed. Ultimately, the model should be used to evaluate nutrient load reductions (and estimate future load reductions) from watershed management initiatives such as the Watershed Agricultural Program, the Watershed Forestry Program, the Wastewater Treatment Plant Upgrade Program, the Septic Rehabilitation and Replacement Program and urban stormwater runoff reduction efforts. The model may also be used to estimate the protection attained through the Land Acquisition Program. NYCDEP has made significant progress in developing a terrestrial model which will be able to meet these and other water supply management objectives. As the reservoir models (see the next section) are completed and linked with GWLF, NYCDEP will have a powerful tool to evaluate the impacts of land use practices on water quality. In addition, improved capacity of the model to forecast current conditions and future reductions will be useful in developing Phase III Total Maximum Daily Loads.

Significant additional data are necessary, however, to maximize GWLF's use as a watershed management tool. Through FAD reporting, NYCDEP has identified several necessary model improvements and additional data needs. **In order to enhance GWLF's utility, EPA recommends that NYCDEP continue to collect water quality monitoring and meteorological data, and to improve and refine the GWLF model.**

GWLF's ultimate use as a predictive, watershed management tool will be limited unless the effects of management practices and land use changes can be accurately translated into the runoff and nutrient concentration parameters in the GWLF model. This is a critical connection. It requires a better understanding of the effects of watershed protection/remediation practices on nutrient concentrations in surface and sub-surface runoff and the ability to "scale up" these relationships from the site-specific to the watershed scale. Only then can accurate coefficients be derived and the models be put to full use. **EPA recommends that the City present a strategy to develop accurate runoff and nutrient coefficients for use in GWLF and a long-term plan for using GWLF in the watershed. The strategy should include a program to: (1) catalog and quantify land use changes due to watershed management practices, (2) initiate land use-specific process studies and (3) collect other data necessary to meet program objectives. When this information is integrated into GWLF, its predictive capabilities as a watershed management tool will be fully realized.**

B. Hydrothermal Models

i. FAD Compliance - The FAD contains several milestones for completing the hydrothermal models for each of the reservoir basins. Calibration and verification of the hydrothermal model for the Cannonsville Reservoir was to be completed by December 1996. The set-up of hydrothermal models for the remaining Catskill/Delaware reservoirs was required to be completed by January 1997, and the assessment of those models was due by June 1997. Calibration and verification of the hydrothermal models for the remaining Catskill/Delaware models was required by January 1998. To date, all FAD milestone dates have been met. The January 1998 report included an assessment that indicated further model development was necessary. In accordance with the FAD, the City identified additional modeling needs and a timeframe for their completion.

ii. Implementation Discussion and Assessment

Cannonsville Reservoir

The one-dimensional hydrothermal model developed for Cannonsville Reservoir, and used for the remaining Catskill/Delaware models, is capable of describing vertical and temporal variations of mass and heat. The primary function of this model is to provide the heat and mass balance framework for the reservoir eutrophication model (otherwise known as the water quality model). Since the model is one-dimensional, it cannot simulate longitudinal variations in eutrophication characteristics that may occur during the summer months; however, the strongest spatial gradients in temperature and constituent concentrations associated with eutrophication and drinking water quality are in the vertical direction (FAD 303c - December 1996).

Meteorological and hydrologic monitoring data, collected from 1988 through 1999 have been used to test the accuracy of model predictions. In 1995, an intensive monitoring program, including on-site meteorological measurements, was implemented. For this reason, greater emphasis was placed on 1995 conditions. The hydrothermal model was operated in hindcasting mode in order to simulate historical conditions and to demonstrate model performance. Hindcasting for the years 1988 through 1995 successfully demonstrated that model simulations agreed well with actual conditions.

A two-dimensional model, CE-QUAL-W2(t), was developed for the Cannonsville Reservoir by the U.S. Army Corps of Engineers. The two-dimensional model simulates temperature gradients and transport dynamics in both the vertical and the longitudinal directions. The hydrothermal component of this model was calibrated and verified for the Cannonsville Reservoir to establish a suitable hydrothermal model for the reservoir that could be used as a physical/transport framework for use with the two-dimensional water quality models. In addition, the model may also be used to support management of reservoir operations related to stratification and mixing regimes and the temperatures of reservoir outflows (FAD 303c December 1996).

Again, model testing was accomplished using data from the 1988 through 1995 time period, with special emphasis place on 1995 data. Parameters were analyzed four different ways to evaluate model

performance: 1) thermal profiles in time and space, 2) time plots of selected features of the thermal stratification regime that depict seasonality, 3) major frequencies/periods of oscillations of bottom currents, and 4) summary statistics that represent a feature of the stratification regime for a major part of the year. For all of the cases listed above, and for all of the years tested, the model simulations matched the observed values fairly well, demonstrating model success.

Remaining Catskill/Delaware Reservoirs

One-dimensional hydrothermal models were developed using the Cannonsville model framework for the remaining Catskill/Delaware models. NYCDEP reported that on-site meteorological data from 1997 were used to support testing of the one-dimensional hydrothermal model for Pepacton and Ashokan Reservoirs; data from both 1995 and 1997 were used for Rondout Reservoir. These three reservoirs were calibrated using on-site meteorological data for 1997. NYCDEP also reported that: (1) testing of the model for the Neversink, Schoharie, and West Branch Reservoirs remains preliminary based on 1995 conditions, (2) calibration of these reservoirs was done using the more completely defined conditions of 1998, and (3) verification will be initiated on 1995 data. Model performance was evaluated quantitatively and qualitatively using the same features of the stratification regimes as in the first round of testing (with the addition of temperature in reservoir withdrawals).

The models for the Rondout, Pepacton, and Ashokan reservoirs have been successfully calibrated and verified. With the exception of the East Basin of the Ashokan Reservoir, the models effectively simulated the seasonal and vertical features of the stratification regimes for these reservoirs. Poor model simulation of the East Basin was likely due to a lack of information on important operational features, such as actual depth of water withdrawal. These models have been sufficiently developed and tested to meet FAD objectives – to support the water quality models and to provide tools to assist in operation and management of the reservoirs.

The two-dimensional model, CE-QUAL-W2(t), that was developed for Cannonsville, was successfully applied to the rest of the Catskill/Delaware reservoirs -- Ashokan (East and West modeled separately), Neversink, Pepacton, Rondout, Schoharie and West Branch reservoirs.

The model was tested for multiple years using NYCDEP's comprehensive monitoring data including inflows and outflows to the reservoirs, in-reservoir temperatures, and meteorological conditions. These data were augmented by USGS measurements of tributary flows and regional meteorological conditions by the National Weather Service. Model performance was tested using data from 1993-1995 for Ashokan East and West, from 1992-1995 for Neversink, Pepacton, Schoharie, and West Branch, and from 1992-1996 for Rondout. With the exception of West Branch Reservoir, the model closely predicted the important features of stratification including: (1) the timing of stratification onset in spring and turnover in fall, (2) the duration of stratification, (3) the dimensions of stratified layers, (4) the temperatures of the stratified layers, and (5) the overall temperature differences in the water column.

In early 1998, NYCDEP recommended that additional testing of these models be performed with on-site meteorological data as it became available. In 1999, the City reported that the water quality framework was tested for Ashokan, Pepacton, and Rondout reservoirs for 1997 data and, in February 2000, NYCDEP reported that testing was complete for the Neversink, Schoharie, and West Branch reservoir models using improved data from 1998. New data sets were developed for reservoir inflow and outflow components, temperature, light extinction coefficients, and water quality profiles.

iii. Conclusions/Recommendations - EPA recommends that NYCDEP continue to refine and verify hydrothermal models with new data sets as they become available and develop a link, if determined to be beneficial, between the two-dimensional hydrothermal models and the two-dimensional eutrophication models. Additionally, EPA recommends that NYCDEP demonstrate how it utilizes these models for management of the reservoir system.

C. Eutrophication Models

i. FAD Compliance - The FAD contains several milestones for completing the eutrophication models for each of the reservoir basins. Calibration and verification of the eutrophication model for the Cannonsville Reservoir was to be completed by December 1996. The set-up of eutrophication models for the remaining Catskill/Delaware reservoirs was required to be completed by January 1998 and the assessment of those models was due by June 1998. Calibration and verification of the eutrophication models for the remaining Catskill/Delaware models was required by January 1999. If the assessment indicated further model development, or data collection was required, the needs and timeframe were to be identified by January 1999. All FAD milestones have been met. By 1999, additional needs were identified and a new schedule was presented to EPA and accepted.

ii. Implementation Discussion and Assessment

Eutrophication Modeling - Cannonsville Reservoir

A one-dimensional eutrophication (nutrient-phytoplankton) model was developed for the Cannonsville Reservoir in order to predict levels of eutrophication in the reservoir due to various nutrient loading scenarios. The model was set up to represent the lacustrine zone of the reservoir. The goal of this model was to develop a reservoir management and operations tool to improve or maintain water quality as it relates to nutrient supply and phytoplankton growth. The Cannonsville eutrophication model simulates the following water quality state variables: chlorophyll, zooplankton, soluble reactive P (SRP), dissolved organic P, available non-living particulate P, unavailable non-living particulate P, ammonia, nitrate plus nitrite, dissolved organic N, non-living particulate N, dissolved oxygen, and temperature. To characterize each of these state variables, five kinetic sub-models were included in the model: phosphorus, nitrogen, chlorophyll, zooplankton, and dissolved oxygen. The Cannonsville model was

also a prototype model that was tested to determine applicability for the rest of the Catskill/Delaware reservoirs.

Intensive monitoring of the Cannonsville Reservoir was conducted in 1995. Though 1995 was a particularly dry year and a major drawdown of the reservoir was experienced, data from that year were used to support calibration of the model. In addition, some model coefficients were determined from system-specific experiments and measurements conducted in 1995. Also in 1995, the sedimentation and resuspension properties of the Cannonsville Reservoir were evaluated. The City determined that drawdown of the reservoir causes resuspension of bottom sediments and can degrade water quality by introducing turbidity to the water column. 1994, the next most data-intense year (reservoir levels were relatively full over model testing period), was used for verification testing of the model.

The model performed well in simulating 1995 observed state parameters with the exception of predicted SRP for the epilimnion, which predicted slightly lower values than those observed. The model's imprecise simulation for SRP was probably due to low detection limits of the analysis at low SRP concentrations. Short-term fluctuations in Chl were not well simulated; however, such short-term limitations are often seen in phytoplankton modeling. Resuspension of bottom sediment was not accounted for in the model. This led to under prediction of particulate phosphorus (PP) and total phosphorus (TP) for part of the testing period. These under predictions, however, did not compromise the overall goal of the model – to provide an effective simulation of phytoplankton biomass and concentrations of important dissolved P and N species as a function of environmental and operational forcing conditions. The successful testing of the model, therefore, met the goals of the program and allowed for progression of the modeling effort to the remaining Catskill/Delaware reservoirs.

Eutrophication Modeling - Remaining Catskill/Delaware Reservoirs

The remaining reservoirs were modeled using the framework established under the Cannonsville modeling effort. Coefficients were selected to suit each reservoir. One- and two-dimensional models were developed:

a. One-Dimensional Eutrophication Models

The models and sub-models used for these reservoirs are very similar to those used for the Cannonsville Reservoir modeling effort. As with the Cannonsville model, these models were intended as a management tool to guide decisions to protect and improve the water quality of that reservoir as it relates to nutrient supply and phytoplankton growth.[23] As with the Cannonsville reservoir model, these models make use of system specific process/kinetic studies and detailed measurements of in-reservoir

[23]FAD Task 303i - *Testing of One-Dimensional Hydrothermal and Eutrophication Models for Six Catskill/Delaware Reservoirs* (NYCDEP, 1997).

and forcing function conditions to support the model testing effort. The models were set-up for the spring-fall interval of 1995, using data collected as part of NYCDEP's ongoing monitoring program.[24]

The Ashokan, Pepacton, and Rondout reservoirs were calibrated using 1997 data which were collected as part of an intensive monitoring program for this effort. System-specific coefficients were developed and used during model calibration. Occurrence of tripton, inanimate particles in the reservoir water column, has been thought to cause increases in turbidity, light attenuation, and particulate phosphorus (and therefore, growth of phytoplankton). For these reasons, a tripton resuspension factor was added to the eutrophication models. Calibration of the models improved significantly as a result of this addition and further improvements are expected with the future addition of a submodel driven by key mechanisms for resuspension. Despite the complications associated with eutrophication modeling, which include reservoir operation complexity, and low mesotrophic status, the models were calibrated successfully.

The Neversink, Schoharie, and West Branch reservoirs were calibrated using 1998 data. The role of tripton in supporting phytoplankton growth was determined to be minor in these reservoirs. Therefore, testing results that incorporated the effects of resuspension were not included in the model testing scenarios. The model was, however, enhanced by the addition of an organic carbon sub-model. The model performed well during this calibration testing round despite the complications of eutrophication modeling listed above.

The final step in model testing is the verification step. It is anticipated that all six reservoir models, with the organic carbon submodel, will be verified using 1999 conditions by 2001 in accordance with an EPA-agreed upon schedule.

b. Two-Dimensional Eutrophication Models

Two-dimensional water quality models, developed from UFI kinetics and the Army Corps of Engineers CE-QUAL-W@(t), can be used to simulate vertical and longitudinal variations in conditions of interest. However, it was noted that "distinct and recurring longitudinal signatures in phytpolankton and nutrient concentrations do not presently prevail in the systems addressed in this work. The signatures are primarily temporal and vertical, and [are] thus appropriately addressed with the one-dimensional nutrient-phytoplankton models developed and tested for these systems."[25] The two-dimensional models could prove useful, however, in addressing future two-dimensional issues and other water quality issues for these systems such as spill occurrences in the various watersheds.

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[24]FAD Task 303g - *Set-up Eutrophication Models for Catskill/Delaware Reservoirs* (NYCDEP, 1998)

[25] FAD Task 303i - *Testing of One-Dimensional Hydrothermal and Eutrophication Models for Six Catskill/Delaware Reservoirs* (NYCDEP, 1999)

iii. Conclusions and Recommendations

The City has produced an impressive set of eutrophication reservoir models and has the expertise to handle future model verification and updating requirements. **EPA recommends that steps identified by NYCDEP to achieve modeling goals be completed. These steps include verification of the rest of the Catskill/Delaware reservoir models for the 1999 data set and continuation of eutrophication model refinement. EPA recommends that NYCDEP continue to demonstrate how it utilizes these models for management of the Catskill/Delaware reservoir system. EPA also recommends that NYCDEP develop a plan to link and integrate reservoir and terrestrial modeling as part of a comprehensive approach to watershed management.**

XI. Total Maximum Daily Load Program

1. Objective

The primary FAD objective for the Total Maximum Daily Load (TMDL) Program is to reduce concentrations of phosphorus in the New York City water supply reservoirs to a level necessary to meet Ambient Water Quality Standards. The secondary objective of the program is to determine if the NYSDEC standard of 20 ug/l is sufficient to protect a drinking water source.

2. Background

Section 303(d) of the Clean Water Act requires states to develop TMDLs for waterbodies that do not meet water quality standards. In order to meet this requirement for the New York City reservoirs, a workgroup was formed, consisting of representatives from NYCDEP, NYSDEC, NYSDOH and EPA. The workgroup's charge was to develop a methodology for NYSDEC to develop TMDLs using technical information supplied by NYCDEP.

The TMDLs in the New York City watersheds are being developed in Phases. Phase I provided an initial assessment of each reservoir utilizing the data and models available at that time. Phase I TMDLs were approved by EPA in April 1997. After completion of Phase I, work began on a methodology for Phase II. This task was completed in March 1999 and NYCDEP submitted technical information to NYSDEC for use in developing Phase II TMDLs in September 1999. NYSDEC proposed Phase II TMDLs in November 1999 and conducted a public review; the public comment period closed in February 2000. NYSDEC has not yet submitted Phase II TMDLs to EPA for approval.

Concurrent with the development of the Phase II methodology, the workgroup reviewed data produced by NYCDEP to develop a guidance value for phosphorus that is protective of the New York City reservoirs' best use as a drinking water supply. A guidance value was not agreed to by the workgroup. However, using a weight of evidence approach, NYCDEP proposed that 15 ug/l guidance value be used in the terminal source water reservoirs (Kensico, Rondout, Ashokan, West Branch, New Croton, Croton Falls and Cross River Reservoirs). In upstream reservoirs, the guidance value would remain at 20ug/l. NYSDEC issued a proposal for public review which utilizes 15ug/l as an interpretation of its narrative standard in source water reservoirs of the Catskill/Delaware System. As the City continues to develop and refine its reservoir models, reservoir-specific guidance values may be developed.

3. Program Assessment

A. FAD Compliance

The 1997 FAD contains several milestones for Phase I and Phase II TMDL development. It outlines commitments made by NYSDEC to propose and by EPA to make a determination on the proposed TMDLs. The FAD also contains a commitment by NYSDEC to modify SPDES permits, as necessary, and to identify potential non-point source management practices to achieve TMDLs. NYCDEP is required to report annually on the non-point source controls implemented and waste load allocations established as a result of NYSDEC's adoption of TMDLs.

All commitments related to Phase I TMDLs have been met. For Phase II, in addition to the NYSDEC and EPA commitments, NYCDEP was required to develop a draft Phase II methodology and submit it to the Technical Advisory Committee for review. The Phase II methodology was finalized in March 1999. NYCDEP was also required to develop Phase II TMDL reservoir reports, including suggested waste load allocations (WLAs) and estimated load allocations (LAs), and submit them to NYSDEC for action nine months from agreement on the Phase II methodology. NYCDEP submitted its Reservoir Reports to NYSDEC in September 1999. In the FAD, NYSDEC commits to proposing TMDLs within six months of receiving the Reservoir Reports. Due to an extended public comment period and the amount of comments received, NYSDEC has not yet submitted Phase II TMDLs to EPA. NYSDEC is committed to finalizing the Phase II TMDLs once the public comments are fully addressed. TMDLs are now expected to be submitted by June 30, 2000. FAD Task 303o-14 and the MOA (Paragraph 162h) commits the State (jointly with the City) to "issue a report identifying potential management practices by the later of January 1, 1999 or six months after submission of Phase II TMDL Reports to NYSDEC." To date, this report, which was due in September 1999, has not been submitted.

FAD Task 303n required NYCDEP to examine the relationship between phosphorus and trihalomethane (THM) precursors and to evaluate the adequacy of the NYSDEC 20 ug/l phosphorus guidance value for protection of a drinking water supply. This report was submitted in December 1997.

B. Program Implementation

i. Phase I

As previously noted, Phase I TMDLs have been approved by EPA, and NYSDEC has modified SPDES permits within the watershed to be consistent with both the NYC Watershed Rules and Regulations and TMDLs. Completion of the Wastewater Treatment Plant Upgrade Program, which is

necessary to achieve WLAs included in the Phase I TMDLs, is discussed in detail in Chapter VIII of this report.

In accordance with the MOA and FAD Task 303o-5, NYCDEP has identified potential non-point source pollution controls to achieve Phase I LAs. Included in these reports are NYSDEC's Statewide Non-Point Management Program, the New York State Coastal Non-point Pollution Control Program and several programs implemented by NYCDEP which are FAD requirements.

Four reservoir basins (East Branch, Bog Brook, Diverting and Muscoot) required non-point source reductions in order to achieve Phase I TMDLs. All of the basins are located within the Croton System. Although the FAD addresses only the Catskill/Delaware Systems, the MOA TMDL commitments cover the entire watershed. In October 1998, NYSDEC issued the report *Non-point Source Management Practices to Achieve Phase I TMDL Load Allocations in the Croton System* which included recommendations for actions to be taken by NYCDEP, NYSDEC, EPA and local governments. The recommended actions, however, are general and do not identify specific activities necessary to achieve Phase I TMDLs. They can be summarized as follows (by "lead" agency):

NYCDEP:
- Implement all elements of the MOA and FAD

NYSDEC:
- Update, implement and fund the Statewide Non-Point Source Management Plan;
- Complete, implement and fund New York State's Coastal Non-point Source Program;
- Update general stormwater permits for industrial categories, including construction; and
- Implement the MOA.

EPA:
- Re-authorize the Clean Water Act; and
- Promulgate Phase II Stormwater Regulations.

Westchester and Putnam Counties:
- Develop the Comprehensive Croton Water Quality Protection Plan;
- Consider using funds provided by NYC through the Water Quality Investment Program to implement projects to reduce non-point source phosphorus loads.

ii. Phase II

Several improvements were made in the methodology to develop TMDLs in Phase II:

- The Generalized Watershed Loading Function (GWLF) model was used in the Catskill/Delaware watersheds;
- The data used to model the watersheds were more recent and spanned four consecutive years;
- The Margin of Safety ranged from 10% to 20% to reflect the variability of phosphorus data for each reservoir;
- Phosphorus retention in upstream large lakes was accounted for;
- The criteria for determining whether a reservoir is adequately modeled were revised; and
- Export coefficients were adjusted.

Although improvements were made in Phase II, NYCDEP is continuing to refine the models used in TMDL calculations. NYCDEP is scheduled to complete eutrophication models for the west-of-Hudson reservoirs by February 2001. A similar effort has been initiated in the east-of-Hudson reservoirs; however, it will be several years before these models are calibrated and verified. NYCDEP is currently assessing the applicability of the GWLF model to the east-of Hudson watersheds for future use in the TMDL process. Recommendations for model development are discussed in Chapter X of this report.

iii. Guidance Value

FAD Task 303n required NYCDEP to examine the relationship between phosphorus and THM precursors and evaluate the adequacy of the NYSDEC 20 ug/l phosphorus guidance value for protecting a drinking water supply. The December 1997 report concluded that there were insufficient data to support a THM-based phosphorus guidance value and that the 20 ug/l guidance value "does not appear adequate for protection of NYC reservoirs." The report stated that additional information is needed to establish a credible THM precursor model. The interrelationships between light, primary production, watershed nutrient loading and THM precursors were identified as areas needing further research. To address these research needs, NYCDEP is conducting a study to quantify and characterize the THM precursors. In addition, the study will examine the relationship between thermal stratification and light attenuation, and nutrient concentrations and phytoplankton biomass. NYCDEP is also cooperating with EPA on a THM Precursor/Simulated Distribution System project.

As indicated in EPA's April 1997 Phase I approval letter, NYSDEC committed to developing "a NYC Watershed specific phosphorus criterion designed to protect the designated best use of the reservoirs for use in Phase II TMDL development." NYCDEP provided a technical report to NYSDEC in March 1999 entitled, *Development of a Water Quality Guidance Value for Phase II Total Maximum Daily Loads (TMDLS)*. This report (1) summarizes the work performed to establish a site-specific phosphorus guidance value, (2) reviews the eutrophication-use impairment information, (3) presents an analysis of phosphorus, algal biomass and related water quality parameters and (4) proposes a phosphorus guidance value of 15ug/l for source water reservoirs.

In June 1999, EPA requested that NYCDEP provide technical justification for applying the proposed guidance value of 15 ug/l only to source water reservoirs. In response, NYCDEP stated that in order to determine technically defensible guidance values for upstream reservoirs, detailed reservoir and terrestrial models need to be linked to model the system as a whole. NYCDEP is continuing to develop both reservoir and terrestrial models and improve the model input data to support the TMDL process (Chapter X).

4. Conclusions/Recommendations

EPA recommends that NYCDEP work with NYSDEC and local governments to identify specific activities that will reduce non-point sources of phosphorus in basins that not do meet their applicable load allocations. EPA recommends that NYSDEC work with the City to submit a report on potential management practices based on the types of land use in the relevant basin and any other basin specific conditions, a report which was due in September 1999 (per the FAD and MOA).

EPA recommends that NYSDEC take action to ensure implementation of non-point source controls to meet Phase I TMDLs.

EPA recommends that NYSDEC expeditiously establish and implement Phase II TMDLs for phosphorus in the New York City Watershed

NYCDEP continues to develop models for use in future TMDL calculations and for calculating reservoir specific guidance values. **EPA recommends that NYCDEP establish a strategy and schedule for completion of reservoir models and terrestrial models that can be used for Phase III TMDLs watershed-wide.**

NYCDEP is implementing an extensive monitoring program. Many components of the monitoring efforts support development of TMDLs. **EPA recommends that the City identify data needs for the development of Phase III TMDLs and for the development of reservoir specific guidance values and/or a health-based guidance value so that the necessary monitoring programs can be designed.**

XII. New York City's Watershed Rules and Regulations and Project Review

1. Background and Objectives

The New York City watershed is home to a number of vital communities. While these communities are important stewards of the watershed, they also generate waste. Waste comes from a variety of point and non-point sources and activities that, if not addressed appropriately, have the potential to degrade and contaminate the City's drinking water supply reservoirs and ultimately its water supply. In accordance with the Surface Water Treatment Rule (SWTR), in order to avoid filtration, a public water system must maintain a watershed control program which minimizes the potential for contamination by pathogens and viruses in the source water. To achieve this goal, the Surface Water Treatment Rule states:

> *The public water system must demonstrate through ownership and/or written agreements with landowners within the watershed that it can control all human activities which may have an adverse impact on the microbiological quality of the source water.*

The City only owns a small part of the watershed that is the source of its drinking water. Therefore, to comply with the SWTR, the City must rely on controlling activities in the watershed that may negatively impact its source water. To that end, in late 1990, the City drafted new watershed regulations meant to supersede the "Rules and Regulations for the Department of Water Supply, Gas and Electricity of the City of New York" enacted in 1953. As a condition of its January 1993 Filtration Avoidance Determination (FAD), EPA required the City to submit "final proposed watershed rules and regulations and the final Environmental Impact Statement" by September 1993. EPA's December 1993 FAD required the City to pursue final promulgation of the new watershed regulations with an implementation date no later than September 1994 (Task 311). In 1994, however, resistance by watershed communities (which were concerned about the impact the regulations would have on their ability to grow) and a failure to obtain approval from the New York State Department of Health (NYSDOH) stopped any progress towards final promulgation.

With the future of filtration avoidance seriously at risk, agreement on new watershed regulations became a major point of negotiation among the City, State, EPA, upstate communities and environmental organizations. The outcome of these negotiations, completed in January 1997, was the New York City Watershed MOA which included, among other things, a commitment by the State and City to approve and promulgate new Watershed Rules and Regulations (WR&R). The WR&R, entitled *Rules and Regulations for the Protection from Contamination, Degradation and Pollution of the New York City Water Supply and its Sources,* became effective on May 1, 1997, paving the way for EPA's 5-year FAD which was signed on May 6, 1997. NYSDOH adopted the WR&R as

State regulations on July 8, 1998. NYSDOH's adoption of the WR&R into its Public Health Law augments the City's legal ability to protect the water supply under State enforcement authority.

Although the 1997 WR&R are less stringent than those proposed in 1991, the City's effective use of its authority under the New York State Environmental Quality Review Act (SEQRA), in conjunction with firm, consistent implementation of the WR&R, together amount to a strong mechanism for addressing future sources of contamination. It is in this context that EPA evaluates the City's ability to address activities that may negatively impact the watershed.

The expressed goals of the WR&R are twofold: (1) to protect public health by averting future contamination to and degradation of the water supply and (2) to remediate existing sources of pollution or degradation. One of the primary means of achieving the second goal is through Section 13-86(a)(10) which requires the upgrade of existing wastewater treatment facilities in the watershed. EPA's assessment of this program (the Regulatory Upgrade Program) is found in Chapter 8. (Chapter 8 also includes a discussion of the City's enforcement program for existing wastewater treatment facilities.) Our evaluation below focuses on the WR&R sections that EPA has emphasized in the FAD and where there has been the most regulatory activity to date:

- Stormwater Pollution Prevention Plans and Impervious Surfaces under Subchapter C (Section 18-39)
- NYCDEP Enforcement under Subchapter E
- Pilot Phosphorus Offset Program under Subchapter H
- Variances under Subchapter F.

We also highlight two issues of concern regarding specific Regulated Activities under Subchapter C:

- Siting of Septic Systems under Section 18-38
- Use of Highway Maintenance Materials under Section 18-45

Finally, we include a discussion of the City's role under SEQRA to address the potential impacts of development on its water supply.

Because a large part of the WR&R is oriented toward preventing the impacts of pollution (either from existing activities or proposed activities), success will be measured by vigilant enforcement of the regulations, water quality monitoring to support enforcement actions and regulatory decisions, and continued compliance with the objective criteria of the SWTR. Additionally, community acceptance of the WR&R (and the City's enforcement presence) is critical for the long-term success of the City's watershed protection efforts. Program-specific monitoring (e.g., phosphorus offset, support of some police/enforcement actions, SPPP evaluations) will supplement watershed-wide monitoring and will

provide additional tools to measure the success of the WR&R. These monitoring programs will be discussed in the appropriate sections below.

2. General FAD Task Compliance

In accordance with FAD Task 311a, ninety days after the effective date of the MOA, the City completed final promulgation of the WR&R and submitted the necessary documentation to NYSDOH for promulgation into State law. Approval of the City's WR&R by NYSDOH was one of the critical tasks necessary for EPA to issue the 1997 FAD. After the City provided NYSDOH with all required documentation, the State went through a promulgation process which ended in the City's WR&R becoming adopted as State regulations on July 8, 1998.

FAD Tasks 308l and 308m required NYCDEP to develop and finalize a guidance manual for implementing the stormwater provisions of the WR&R. The guidance document was completed in July 1997 in accordance with the FAD. The document includes guidance on the preparation of stormwater pollution prevention plans and individual residential stormwater management plans, and permit applications for wetlands and watercourse crossings, piping and diversions.

In accordance with FAD Task 311b, the City is required to implement and administer the new WR&R on a continuous basis. NYCDEP reports on the WR&R and on activities that may adversely impact water quality through a number of different FAD Tasks. Most importantly, the City reports quarterly on the status of activities/projects that "may adversely affect the quality of the New York City water supply" (501a) and on watershed enforcement activities (501b). (A number of FAD Tasks are associated with wastewater treatment plant compliance and upgrades; these are discussed in Chapter VIII.) Additionally, it submits a *Quarterly Report on the Status of Implementing Projects Designed to Reduce Nonpoint Source Pollution* (308i). Included in this report, among other things, is the status of the phosphorus offset program, stormwater pollution prevention plans, wastewater control projects. The City's Annual Report (901a) also includes an overview of its implementation of a number of WR&R related programs. The City reports on the phosphorus offset program through the FAD Task 312s series.

The information that NYCDEP submits through these FAD Tasks meets the intent of the FAD and affords EPA with sufficient information to evaluate implementation of the WR&R. We note that there have been numerous instances in which EPA has requested follow-up information from the City on a particular issue or project. The City has been forthcoming and timely in submitting additional

information to EPA upon request. An evaluation of the City's progress on WR&R implementation to meet the watershed protection goals of the 1997 FAD is discussed below in detail.

3. Assessment

A. Stormwater Pollution Prevention Plans and Impervious Surfaces

i. Implementation - Pursuant to Section 18-39 of the WR&R, the City requires review and approval of Stormwater Pollution Prevention Plans (SPPPs), Individual Residential Stormwater Permits (IRSPs), and Crossing, Piping or Diversion Permits (CPDPs) before certain construction activities take place. This section of the regulations is intended to protect the quality of the City's water supply by "preventing erosion and sedimentation during construction, and ensuring that the rate and quality of post-construction stormwater runoff is not substantially altered from pre-development conditions."[26] SPPPs include Best Management Practices (BMPs) that control erosion and pollutant loadings to reservoirs, watercourses and wetlands during and after construction.

SPPPs are required for a number of new projects meeting a number of thresholds set forth in the WR&R, the broadest of which are: (1) disturbance of five acres or more; (2) disturbance of at least two acres if any portion of the disturbance is within 100 feet of a watercourse or wetland or on a slope greater than 15%; (3) creation of an impervious surface totaling over 40,000 square feet; and (4) construction of any new impervious surface allowed to be constructed within limiting distances. SPPPs are prepared and implemented generally in accordance with the New York State Department of Environmental Conservation (NYSDEC) General Permit for Stormwater Discharges from Construction Areas (GP-93-06). However, the WR&R include a number of enhancements in the New York City watershed over the Statewide stormwater program. In the New York City watershed, SPPPs (1) are required in more circumstances than under the State program, (2) must be approved by the City, (3) must include a phosphorus analysis, and (4) depending on basin status, must include a coliform analysis. Table XII.1 shows the number and status of applications in the watershed.

Table XII.1 shows that WR&R have required SPPPs or permits for many more projects than would have been required under NYSDEC regulations alone. Strictly as a result of the WR&R, 47 additional development projects were required to reduce post-development pollutant loadings through the SPPP or permit process. Two criticisms of the SPPP program have been raised during this mid-course FAD review and are addressed below.

[26] Applicant's Guide to Stormwater Pollution Prevention Plans and Crossing, Pipe or Diversion Permits (NYCDEP, May 1997)

Table XII.1 - Status of Applications for SPPPs, IRSPs, and CPDPs that were subject to NYCDEP review and approval between May 1997 and December 1999.

Reservoir Basin	SPPPs Reviewed	SPPPs Approved	IRSPs Reviewed	IRSPs Approved	CPDPs Reviewed	CPDPs Approved	Projects Subject to NYCDEP & NYSDEC Stormwater Regs.	Projects Subject to NYCDEP Stormwater Regs. Only
Ashokan	6	5	3	3	0	0	1	8
Rondout	2	1	0	0	1	1	1	2
Schoharie	10	6	2	1	3	2	3	12
Neversink	0	0	1	1	0	0	0	1
Pepacton	6	3	3	3	0	0	1	8
Cannonsville	9	5	1	1	1	1	3	8
Kensico	10	1	1	0	0	0	4	7
W. Branch	2	0	0	0	0	0	1	1
B. Corner	0	0	0	0	0	0	0	0
Total	45	21	11	9	5	4	14	47

Pre- and post-development runoff or pollutant loading

Some commenters questioned whether appropriate models are being used to calculate pre- and post-development runoff, pointing out that formulas used by developers are flawed and favor irresponsible development. Consistent with New York State's General Permit, NYCDEP's guidance allows the applicant to chose from a number of different methods in making calculations. Model selection depends upon a number of variables including the size of the land disturbance and the amount of input data. However, it is important that estimations include as much site-specific data as possible and that the most conservative measures are utilized to reduce stormwater loadings. (A recent study by the Water Resources Institute at Cornell University found that for small projects [less than three acres] estimated phosphorus loading rates using different models, including the "simple model" were very

similar.[27]) Regardless of which model is used, the result must be BMPs that are designed, built and maintained consistent with Section 18-39 of the WR&R with an overall goal of no net increase in loadings over pre-existing construction conditions.

The majority of the projects subject to review are relatively small; thus, with appropriate BMPs, pollutant loadings can be well managed. As noted by the National Research Council, with small, low-density development projects of 5 to 25% impervious cover, "the reduction in phosphorus load by stormwater BMPs keeps pace with the increased load produced by impervious cover. After that point, however, stormwater BMPs can no longer achieve predevelopment phosphorus loads."[28] Thus, with large development projects, the uncertainties and potential impacts become much greater. To address the environmental impacts (e.g., stormwater runoff) from large projects, it is important that the City vigorously apply its authority under SEQRA. Through SEQRA, the City can work to reduce the project's footprint during the planning stage - a much more effective mechanism to reduce stormwater runoff than to rely solely on BMPs. The City's role in SEQRA is discussed in more detail at the end of this chapter.

The SPPP program, over time, is developing into a performance based program. There are three efforts underway by the City to lead the program in that direction. First, the City has committed to a comprehensive evaluation of the removal capabilities and maintenance requirements of up to four types of stormwater management facilities. Through this program, begun in 1999 and partially funded through the federal Water Resources Development Act, the City will obtain substantial information on stormwater BMP effectiveness. In another program, partially funded through 1998 Safe Drinking Water Act funds, the City is sampling upstream and downstream locations at two proposed development sites to obtain comprehensive water quality information. Monitoring pre- and post-development will be useful in assessing the efficiency of the BMPs installed to minimize water quality impacts. Finally, the City is developing a comprehensive plan to evaluate the BMPs that are being installed around the Kensico Reservoir. These three monitoring programs will provide a significant amount of data which the City should use to refine and enhance the SPPP program. This information will also provide a basis for the
long-term evaluation of this element of the WR&R.

SPPP review/approval process

Public feedback during the mid-course FAD review indicated a general frustration regarding NYCDEP's SPPP review/approval process. In particular, there were complaints that the City's

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[27] *A Demonstration and Monitoring Project for Reducing Phosphorus in the Cannonsville Drainage Basin* - a working paper (Water Resources Institute, Cornell U., January 2000)

[28] *Watershed Management for Potable Water Supply, Assessing the New York City Strategy* (National Research Council, 2000), pg. 418

review process was lengthy and cumbersome in relation to the small size of some of the projects being evaluated. In addition, there has been confusion among engineers and applicants as to what an SPPP requires versus what are only recommendations - an important distinction when the City will pay only for what is required under the WR&R that is not otherwise required by state or federal law. Watershed stakeholders also complained that the City was inconsistent in defining a "watercourse" for particular projects (which often times triggers the need for a SPPP).

Some of these problems derive from the fact that regulating stormwater management is new in the watershed and that the regulations and existing guidance lend themselves to uncertainty and conflict. The City has stated that it has developed draft guidance to help applicants and NYCDEP staff determine the presence and limits of watercourses. It is important that this guidance be finalized expeditiously, and that it be accompanied by appropriate training so to minimize such conflicts in the future. In most instances, it appears that problems could have been resolved if clear lines of communication had been developed early in the SPPP process. As EPA stated in the Public Education section of Chapter VI, it is critical that there be a continuation of efforts to strengthen communication with and gain the trust of communities. More recommendations are provided below.

ii. Recommendations - Regardless of which model is used to develop SPPPs, the result must be BMPs that are designed, built and maintained consistent with Section 18-39 of the WR&R with an overall goal of no net increase in loadings over pre-existing construction conditions. **EPA recommends that NYCDEP ensure that SPPPs include as much site-specific data as possible and that the most conservative measures are utilized to reduce stormwater loadings.**

With large development projects, the uncertainties built into stormwater models and potential impacts of stormwater runoff become much greater. **To address the environmental impacts from large projects, EPA recommends that the City vigorously apply its authority under SEQRA.** Through SEQRA, the City can work to reduce the project's footprint during the planning stage - a much more effective mechanism to reduce stormwater runoff than to rely solely on BMPs. **In addition, EPA recommends that the Lead Agency under SEQRA ensure that the project applicant initiates the SPPP early and on a parallel track with the project planning process to more effectively and efficiently address water quality concerns**.

EPA commends the City on its new monitoring initiatives that are meant to provide performance based information on BMPs. This information should enhance the effectiveness of the SPPP program and provide a basis for the long-term evaluation of this element of the WR&R.

There is some confusion among consulting engineers and applicants on SPPP requirements on relatively small projects. This has resulted in long delays in the NYCDEP approval process and frustration among watershed residents and businesses. **EPA recommends that the City develop more explicit guidance on SPPP requirements and BMP criteria and apply this guidance in a consistent manner. EPA recommends that NYCDEP spearhead watershed workshops or**

meetings (attended by NYCDEP engineering staff and upper management as well as consulting engineers and town officials) to address community concerns regarding SPPPs. Implementation of SPPPs for these small projects should provide an example as to how well the WR&R can work in the watershed. SPPPs should be an effective tool in protecting the City's water supply and only a nominal burden on the regulated community; that is, should be an opportunity for the City to gain community buy-in of the Regulations, not to lose it.

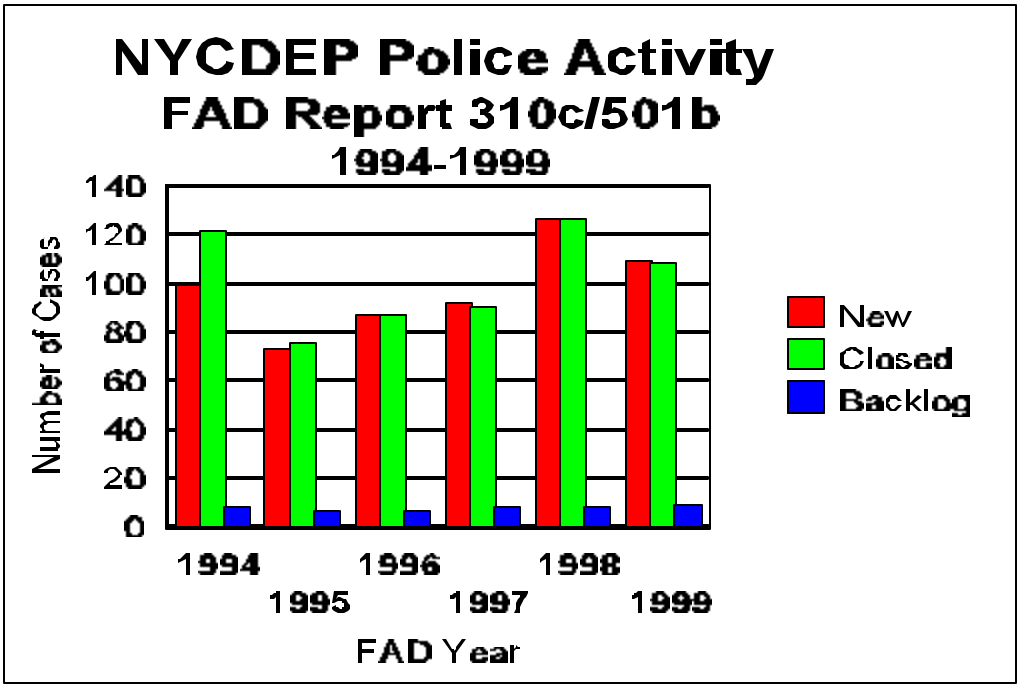
SPPPs may require a coliform analysis, depending on whether the proposed project is in a basin that is considered "coliform restricted." To date, NYCDEP has not conducted a review of all reservoirs and controlled lakes for the purpose of determining whether the Water Quality Standards (Section 18-48 of the WR&R) have been met with respect to total coliform and fecal coliform. **EPA recommends that, in accordance with the WR&R, NYCDEP conduct this review annually and publish the results in a report that will be made available to the public (including on the City's website).**

B. NYCDEP Police Enforcement

i. Implementation - NYCDEP's police force, comprised of an Environmental Enforcement Division and Patrol Division, is responsible for conducting routine sector patrols 24 hours per day, developing cases and pursuing watershed polluters. The Patrol Division is generally responsible for patrolling the watershed and looking for violations or pollution problems. The Environmental Enforcement Division develops cases and follows up as necessary.

The police force investigates new construction, illegal dumping, sewage discharges, spills, and any other activity that may threaten watercourses and reservoirs. It also provides compliance assistance and prosecutes violators of the WR&R. In addition, NYCDEP maintains a Protection Section that, while primarily involved in septic system compliance, also patrols west-of-Hudson, supplementing the efforts of the Patrol Division. (NYCDEP assigns a significant amount of enforcement resources on wastewater treatment plant compliance. The status of that program is discussed in detail in Chapter VIII. The septic system compliance program is discussed in Chapter VII.)

Figure XII.1NYCDEP Police Activity - New, Closed, and Backlogged Cases (1994 - 1999)



The City's 1991 Long-Term Filtration Avoidance Plan committed NYCDEP to watershed protection staff enhancements. These commitments became a general condition for filtration avoidance in the January 1993 FAD and required the City to acquire new staff in all watershed protection programs, including the NYCDEP police. By 1995, the total police force had increased from 29 to approximately 55 officers. Subsequent FADs require the City to maintain staff levels within all watershed protection programs necessary to assure compliance with filtration avoidance criteria. EPA tracks the activities of the NYCDEP police in the watershed through quarterly FAD submittals (FAD Task 501b - a revision of 310c from the December 1993 FAD). Each report includes brief explanations of new, closed, and ongoing police cases from
the previous quarter. Figure XII.1 (based on information provided in FAD Tasks 310c/501b) summarizes police activity since the December 1993 FAD. From 1994 through 1996, NYCDEP police opened 290 cases and closed 284 cases averaging one new case every five days. Since 1997, NYCDEP police opened 327 cases and closed 324 cases averaging a new case every three to four days. There has been a general upward trend in police activity since 1995. We note that these activities do not necessarily result in an arrest, notice of violation, or notice of warning. However, they encompass the substantial universe of formal police actions and are therefore a measure of police vigilance in the watershed.

Since 1995, there has been criticism of NYCDEP's police staffing level and of NYCDEP's ability to retain police officers (low pay, morale, etc.). Although the 1997 FAD does not specifically address

NYCDEP personnel matters, it does require the City to maintain staff levels necessary to assure compliance with filtration avoidance criteria. High turnover and low morale clearly impact the police force's ability to do its job effectively. An ineffective police force will ultimately impact the City's ability to control activities detrimental to the watershed.

Additionally, as EPA noted in its 1999 Annual On-Site Inspection Report (Appendix A), increased perimeter security near the City's aqueduct intakes is an important element of a comprehensive watershed protection program. The City has reported for some time that it intends to restructure salaries to retain officers and attract new ones (salary increases were approved in late March 2000). In addition, as of December 1999, NYCDEP reported that it hired 52 new police officers and that 23 were in the process of being hired. The City intends to increase NYCDEP's uniformed police force from 55 to 136. Of that number, NYCDEP will assign 102 officers to the Patrol Division, significantly enhancing water supply security.

ii. Recommendations - We commend the City for its recent staff and salary increases for its police force. NYCDEP will become a more effective presence in the watershed. Because the staff increase has been so substantial (a more than doubling of its baseline force), **EPA recommends that the City present to EPA an overview of how these additional resources will be allocated to benefit its watershed protection program. EPA also recommends that the police coordinate with City engineers. In addition, EPA recommends that the City develop a training program so that the police officers are knowledgeable of, and are able to effectively inspect, watershed activities such as erosion controls, BMP maintenance, etc.**

With this increased police presence in the watershed communities**, EPA recommends that the NYCDEP police force provide community outreach through public meetings or informal information sessions to discuss its mandate in the watershed.** Providing early outreach should help to diffuse initial skepticism and build trust between the police and the watershed communities.

C. Variances

i. Implementation - In accordance with Subchapter F of the WR&R, the NYCDEP Commissioner or First Deputy Commissioner, may grant a variance from the requirements of the WR&R. Among other things, a variance application must "identify the provision in the WR&R for which the variance is being sought," demonstrate that it is the "minimum necessary to provide relief," demonstrate that mitigation measures are "at least as protective of the water supply as the standards for regulated activities," and "compliance with the identified provision of the WR&R would create a substantial hardship due to site conditions or limitations." There is also a specific variance provision for wastewater treatment plants in phosphorus and coliform restricted basins. It is EPA's expectation that variances will be few and that NYCDEP will be very conservative in their approval. The following is a discussion of the three variance requests to the WR&R that the City has received through 1999.

Junk Yard Variance - Fleischmanns

In August 1999, NYCDEP approved a request for a variance from Section 18-41(a) of the WR&R regarding the siting of a junk yard within the 250 foot limiting distance from a watercourse. The variance request had come soon after NYCDEP had determined (March 1999) that a proposed operation in Fleischmanns constituted a junk yard and could not be permitted on the property.

This project has a history going back to August 1997 when the City originally determined that the facility did not constitute a junk yard and could be permitted subject to certain conditions. Residents in Fleischmanns informed EPA of this issue and, in response to their concerns, EPA wrote in September 1998 that "we expect New York City and New York State to strictly apply the Rules and Regulations to all activities, including the siting of a junk yard - the definition of which is clear and straightforward. The Fleischmanns situation is no different."

NYCDEP's August 1999 variance approval contained three pages of conditions. The variance essentially linked the operation of the new facility with the closing of an existing operation in the town center, directly adjacent to Bush Kill Creek. It also set up a series of operating restrictions on the new property. In early January 2000, the City withdrew its pending variance determination of August 1999 due to an inadequate SEQRA review. (The variance had not yet taken effect because the applicant had not yet countersigned the City's determination.) Based on correspondence to date, it appears that the variance request will come up again shortly.

Conclusions/Recommendations - This is an example in which poor decisions early on created difficulties in the application of the City's variance provision for both the applicant and NYCDEP. Threats to the water supply are more effectively and appropriately addressed in a direct manner --- through the enforcement of the City's WR&R. **EPA recommends that NYCDEP ensure that any future variance applications result in variance conditions that are implementable and enforceable.** EPA does not consider the draft Fleischmanns variance to have been an appropriate use of the variance provision under the WR&R.

Technology Variance - "Zenon" Sewage Treatment

The Zenon sewage treatment system is a package treatment plant utilizing a compact membrane bioreactor (MBR) arrangement designed to provide advanced tertiary treatment of sewage waste. The Zenon system also includes wastewater recycling technology for water conservation and reuse. During 1997, Zenon representatives applied to NYCDEP for approval of their treatment technology for use in the New York City watershed. The NYCDEP responded with concerns that the Zenon system was a new alternative technology, untried in the watershed, and was not consistent the requirements of Section 18-36 (Wastewater Treatment Plants) of the WR&R. NYCDEP determined that, along with

other requirements, the Zenon process would be considered secondary treatment which must be followed by sand filtration and microfiltration or an approved equivalent technology. (Zenon had maintained that its package plant was an advanced tertiary system.) In late 1997, Zenon representatives petitioned NYCDEP with a request for a variance from the technological requirements for surface water discharge under the WR&R. Alternatively, it requested to modify Section 18-36 of the WR&R to allow use of its technology.

Conclusion **- NYCDEP made an environmentally conservative decision by denying both requests.**

WWTP Expansion Variance - Village of Delhi

In accordance with Section 18-61(d)(2) of the WR&R, an applicant can request a variance from the prohibition of expanding an existing surface discharging WWTP within a phosphorus restricted basin for reasons other than to correct a release or discharge of inadequately treated sewage into the water supply. In addition to the general variance requirements, every one kilogram of projected increase in phosphorus load (from both the expansion of the WWTP and accompanying non-point source runoff) must be offset by two kilograms of reductions in phosphorus loading within same reservoir basin as the WWTP.

The Village of Delhi currently owns and operates a WWTP permitted to discharge 515,000 gpd to the West Branch of the Delaware River. Two private industries, DMV International and Ultra Dairy, treat their combined wastewater at a 200,000 gpd WWTP owned and operated by Ultra Dairy located downstream of the Delhi WWTP. The Village and two industries are located adjacent to the river in an economically depressed area within the phosphorus-restricted Cannonsville basin. The Village of Delhi and Ultra Dairy are participants in the Regulatory Upgrade Program (discussed in Chapter VIII of the report) and are required to upgrade their WWTPs by May 2002 in accordance with the FAD, Watershed MOA, and WR&R. However, in 1996, the two industries approached the Village with a proposal to divert their existing 200,000 gpd plus an additional 100,000 gpd of pre-treated wastewater from their facilities to the Delhi WWTP. In mid-1998, the Village and businesses were informed by NYCDEP that two variance applications would be required: a variance under Section 18-61(d)(1) of the WR&R, with respect to the 200,000 gpd of additional capacity to accommodate the wastewater currently treated at the Ultra Dairy WWTP; and a variance under Section 18-61(d)(2) of the WR&R, with respect to the 100,000 gpd of additional capacity to accommodate future business expansion at DMV International and Ultra Dairy. These two variance applications are currently pending and require final NYCDEP approval before implementation. The proposed expansion of the Delhi facility would result in the decommission and removal of the Ultra Dairy WWTP from the Regulatory Upgrade Program and the requirement that the Village meet 2:1 offset requirements for the additional 100,000 gpd for future growth. This variance application is in addition to a separate application being considered by the Village for a 100,000 gpd expansion to the Delhi WWTP under the Pilot Phosphorus

Offset Program. The Pilot Phosphorus Offset Program requires a 3:1 offset and is discussed separately, below.

Consistent with the general variance provisions in the WR&R, the applicant (Delhi) must demonstrate that substantial hardship would be sustained by the community in order to comply with the regulation for which the variance is requested, subsurface discharge is impossible, the variance is as least as protective of the water supply, and is the "minimum necessary to afford relief." Accordingly, Delaware County should utilize the full capacity of the Pilot Phosphorus Offset Program (100,000gpd), prior to the City granting a variance for new or expanded WWTPs.

In order to comply with the 2:1 offset requirement for the variance, Delhi's application proposes to reduce the permitted phosphorus discharge from 0.2 mg/l (final SPDES permit limit required for the Delhi WWTP) to 0.15 mg/l, through additional phosphorus controls. Additionally, it proposes "zero-discharge" to the river by spray irrigation to a golf course and/or discharge to infiltration galleries in an agricultural field for eight months of the year. In accordance with the WR&R, Delhi would be allowed to apply the resulting phosphorus point-source loading reduction (not related to expansion for growth) towards meeting the 2:1 phosphorus offset requirements.

EPA supports consolidation of waste streams and the successful implementation of phosphorus offset concepts proposed. However the current permitted waste streams at the Delhi and Ultra Dairy WWTPs must comply with the Regulatory Upgrade timeframe requirements specified in the FAD, Watershed MOA, and WR&R.

Conclusions/Recommendations **- EPA agrees with the concept of utilizing the phosphorus offset variance option by the Village of Delhi in accordance with the general variance provisions.** It addresses the needs of an economically depressed community and includes phosphorus point-source reductions that are measurable and enforceable through a SPDES permit, resulting in no decrease in water quality. However, this project, which was introduced conceptually to NYCDEP and Delaware County in 1996, has yet to reach a final agreement among involved parties. **EPA recommends that a timely decision on the expansion/consolidation variance proposal be made so that the regulatory upgrades required by May 2002 (in accordance with the FAD, Watershed MOA, and WR&R) can proceed.**

D. Pilot Phosphorus Offset Program

i. Objective and Description - The Pilot Phosphorus Offset Program is defined in Section 18-82(g) for Putnam County (Croton system) and in Section 18-83(a) for the west-of-Hudson watershed. Its objective is to "evaluate the effectiveness of phosphorus offsets as a potential basis for allowing construction of new...or expansion of existing [wastewater treatment plants]...within phosphorus restricted basins." (The WR&R prohibit new or expanded WWTPs within the 60-day

travel time to intakes; therefore, this program is not allowed within those areas.) The information gained in the pilot program will be used by NYCDEP to determine whether a permanent phosphorus offset program should be developed. In accordance with the MOA and the WR&R, if there is sufficient data, this determination will be made in May 2002; otherwise a determination will be made in May 2007.

To participate in the Pilot Phosphorus Offset Program, the WR&R require Delaware County (the location of the only phosphorus restricted basin west-of-Hudson) to prepare and implement a "Comprehensive Strategy" that "identifies economic resources, water quality problems with potential remedies, and potential strategies and recommendations for economic development initiatives that would protect water quality." The program allows for a maximum of three new and/or expansions of existing WWTPs with a total aggregate SPDES permitted flow of 100,000 gpd in the phosphorus restricted Cannonsville basin.

Similarly, in the Croton system, Putnam County (Westchester County is not participating in the offset program) must agree to develop a Comprehensive Croton System Water Quality Protection Plan (Croton Plan). The Program allows for a maximum of three plants with 150,000 gpd total flow in phosphorus restricted basins east-of-Hudson (EOH). The maximum total phosphorus limit is 0.2 mg/l and the phosphorus loading from the new point source plus associated non-point source loadings resulting from the new construction must be offset by a factor of 3:1 from other point and/or non-point source loadings within the same basin.

ii. FAD Task Compliance - The FAD requires NYCDEP to update EPA semi-annually on the status of applications to the Pilot Phosphorus Offset Program. NYCDEP has met the requirements of FAD Task 312s-1 by submitting semi-annual status reports since issuance of the 1997 FAD. NYCDEP has also met the requirements of 312s-2 by submitting a methodology for determining the credit quantification of the pollution contribution and projected offsets. FAD Task 312s-3 requires NYCDEP to coordinate with NYSDEC to assure issuance of appropriate SPDES permits incorporating the 0.2 mg/l phosphorus discharge limit and required phosphorus offsets. To date, NYSDEC has issued one SPDES permit east-of-Hudson (EmGee Highlands), in accordance with FAD Task 312s-3. (Information from Croton projects will be used by NYCDEP to determine whether a permanent offset program should be developed watershed-wide; therefore, EPA is including Croton projects in the mid-course FAD assessment.)

iii. Implementation and Assessment - In November 1999, Delaware County prepared and submitted a draft Comprehensive Strategy or Action Plan (DCAP) as required to participate in the pilot phosphorus offset program. It is currently under review by NYCDEP. Putnam County has begun preparation of its strategy, but it has not yet been submitted for NYCDEP review. NYCDEP has reported on one potential applicant to participate in the program in Delaware County; there have been three applicants allowed to participate in Putnam County.

Delaware County - Delhi WWTP- The scope of this proposed project is described in the previous section on variances. Delhi has requested to participate in the Pilot Phosphorus Offset Program for a 100,000 gpd expansion of its existing WWTP to accommodate future growth in the area. In accordance with the Program requirements, the phosphorus loadings from the expansion (point and non-point) must be offset at a 3:1 ratio. As offsets, the Village of Delhi proposes to reduce the final SPDES permitted phosphorus limit at its WWTP from 0.2 mg/l to 0.15 mg/l including phosphorus permitted reductions at other existing WWTP in the basin, through additional phosphorus controls. It also proposes to reduce the point source load to zero for eight months of the year by diverting the entire Delhi WWTP discharge to irrigate a golf course (infiltration galleries on an agricultural field would be used as back up).

Putnam County - In 1998, NYCDEP conceptually approved two proposed projects (Kent Manor and EmGee Highlands) for inclusion in the Program. In 1999, the City conceptually approved a third project (Campus at Field Corners). The flow capacity breakdown for Kent Manor, EmGee Highlands, and Campus at Field Corners is 70,000 gpd, 12,000 gpd, and 68,000 gpd respectively, which equals the total flow allocation of 150,000 gpd for the Croton Program. (During 1999, the Kent Manor development proposal did not attain municipal or county approval as required by the WR&R and was subsequently dropped from the Program.) The EmGee project received a SPDES permit in September 1999. The enforceable permit includes enhanced stormwater removal with periodic monitoring and maintenance requirements.

iv. Conclusions/Recommendations - The Pilot Phosphorus Offset Program is being piloted for a fixed time period and includes a fairly restrictive "cap" on participation. According to the WR&R and the MOA, NYCDEP will only decide to implement a permanent program if actual phosphorus offsets have been achieved. Thus, monitoring is a critical element of the Pilot Phosphorus Offset Program. (EPA also notes that the City is instituting an evaluation/monitoring program for management practices in the watershed - see this Chapter, Section 3[A][i] for more information.). Offset reductions are enforceable through each participant's SPDES permit. The City requires a Contingency Plan that identifies the offset mechanisms that will be implemented in the event the offset plan fails to meet the required phosphorus reductions. However, during the FAD mid-course review, the concern was raised that if the pilot program is not successful, the watershed will be left with additional phosphorus discharges to reservoirs that are already degraded. EPA expects that due to the limited scope of the program, along with a number of built-in requirements and restrictions, even if the Pilot Phosphorus Offset Program is not fully successful, the addition of phosphorus to the New York City watershed will be minimized.

The MOA requires NYCDEP to provide a "report on the effectiveness of the pilot offset program for WWTPs in phosphorus restricted basins set forth in Sections 18-82 and 18-83 of the Watershed Regulations" prior to the fifth anniversary of the MOA. To date there is no mechanism in place to guide that determination. **EPA recommends that the City develop a set of criteria that it intends to use to evaluate the effectiveness of the Pilot Phosphorus Offset Program well in advance of the five-year point.**

E. Other Concerns Regarding Regulated Activities under the WR&R

i. Septic System on Slopes

In August 1998, after significant pressure from environmental parties and EPA, NYSDOH rescinded its 1995 general waivers to Putnam, Westchester and Dutchess County Health Departments from some of the requirements of 10NYCRR, Appendix 75-A. The waivers had allowed for residential septic system absorption trenches in-situ soil with slopes greater than 15% but less than 20%. Subsequently, the Counties looked to State guidance and Appendix 75-A to clarify siting requirements with respect to slopes. However, the guidance and legal requirements of Appendix 75-A do not match:

> **Appendix 75-A** - "*slopes greater than 15% are unacceptable*" and "*the natural surface shall not be significantly disturbed*"
>
> **State Guidance** - slopes "*not exceeding 20% may be modified (i.e., cut and/or fill) to meet the maximum 15% slope requirement.*"

In September 1998, in response to a request from the Counties for clarification, the City sent a memo expressing the City's willingness to permit new septic systems on natural slopes up to 20%, as long as the slope is "modified" to 15% using fill material, deferring to State guidance rather than regulation.

Failing septics are a real problem in the watershed. **In light of this, EPA does not find slope modification at a multi-county level to be an acceptable practice.** The City's Septic System Rehabilitation and Replacement Program has found that, based on the number of inspections conducted and the number of NOVs issued, approximately 50% of septic systems throughout the west-of-Hudson watershed may need to be repaired or replaced. The City is spending tens of millions of dollars through several different partnership programs to address this problem.
As borne out by the evaluation conducted by the MOA Technical Advisory Committee (TAC) in 1999, there are many factors that could lead to septic failure. The TAC study found that:

- Steeper sloped sites often require sophisticated engineering design/construction techniques,

- The more complicated the design, the higher the likelihood of improper construction and increased reliance on vigilant operation and maintenance (O&M), and

- The majority of septic system failures occur because of improper construction and insufficient O&M.

EPA is currently evaluating outside peer reviewers' comments on the TAC's findings. But with these general findings in mind, EPA believes that it is prudent environmental policy to minimize as much as possible any factor that might add to the risk of failure of newly installed septic systems. **EPA recommends that NYCDEP (with the support of NYSDOH) enforce the plain and unambiguous reading of Appendix 75-A and not allow septic systems on slopes greater than 15% and not allow septic systems that need significant grading for the expressed purpose of reducing the slope to 15%. EPA also recommends that NYSDOH modify its guidance to be consistent with the language in its regulations.**

ii. The Use of *Ice Ban* in the Watershed

In June 1998, NYCDEP received a request from the Delaware County Department of Transportation to use *Ice Ban*, a de-icing product, on the County's roadways in the NYC watershed. *Ice Ban* is a liquid anti/de-icer made from concentrated liquid residues from the initial steps of corn processing and beer brewing. (The NYSDEC had earlier [January 1998] granted a beneficial use determination [BUD #375-8-37] for *Ice Ban* to be used as a road salt substitute or salt extender statewide.) As a result of Delaware County's request, NYCDEP evaluated the chemical composition and potential water quality impacts associated with its use in the watershed. NYCDEP's primary concern was that *Ice Ban's* high Biological Oxygen Demand (BOD) and phosphorus loadings could contribute to algal blooms in receiving reservoirs and their subsequent eutrophication.

In November 1998, the State of New York Office of the Attorney General requested that NYSDEC rescind the BUD for *Ice Ban's* use in the NYC watershed citing NYCDEP's concerns about its potential impact on the water supply. In early 1999, NYCDEP commissioned an evaluation on the bioavailability of phosphorus in *Ice Ban*. The evaluation confirmed that City's initial concerns were well founded. It showed that a significant amount of total phosphorus is in the dissolved reactive form which is available to stimulate algal production. It also contained very high BOD concentrations.

NYCDEP concluded that *Ice Ban's* use in the watershed is contrary to the City's efforts to reduce nutrient loading.[29] NYCDEP has taken an environmentally sound position by voicing strong concerns

[29]Additional laboratory tests are being performed by the Environmental Technology Evaluation Center (EvTEC), under the auspices of the American Society of Civil Engineers. EvTEC's objective is to provide baseline

on the use of *Ice Ban* in the watershed. Cooperatively, the NYS Department of Transportation has taken prudent measures by limiting the use of *Ice Ban* only on state roads outside of the watershed pending further information. To date, no voluntary commitments have been made by the watershed counties and municipalities to prohibit use on county/local roads. **Based on information presented to date, EPA recommends that NYCDEP and New York State continue to work together to eliminate the threat posed by the use of *Ice Ban* in the watershed through voluntary measures or enforcement of the WR&R and/or a revision of the BUD**.

F. State Environmental Quality Review Act (SEQRA)

i. Discussion

The New York State Environmental Quality Review Act (SEQRA), regulated in 6 NYCRR Part 617, is an extremely powerful tool to address the potential negative environmental impacts of development projects. It's purpose is to "incorporate the consideration of environmental factors into planning, review, and decision-making processes of state, regional and local agencies at the earliest possible time." The City is considered an "involved agency" under SEQRA for watershed projects. As such, it has significant power to control environmentally unsound development in the watershed by ensuring that issues it raises during the SEQRA process are adequately addressed prior to a project moving forward. From EPA's perspective, effective utilization of the City's authority under both SEQRA and the WR&R is necessary to address activities that may adversely impact water quality in the watershed.

Public concern has been expressed over the last several years that the City has not been involved in the SEQRA planning process, and that this inactivity has essentially forced all environmental concerns to be addressed "at the end of the pipe," during the development of an SPPP. Developers have raised concerns that by not getting the City's input early, they are forced to make expensive design changes late in the project development phase. In addition, a project is often conditionally approved by a town, with full acceptance contingent upon the City's approval of the SPPP. The City is then pressured to "work around" a pre-approved design during the development of an SPPP and to approve it quickly. This further constrains the potential effectiveness of the SPPP.

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environmental data on the chemical content, biodegradability and toxicity of *Ice Ban*. Its report is due in the fall of 2000.

ii. Conclusions/Recommendations

Coordination and participation in project review of Type I (and unlisted) actions under SEQRA are critical NYCDEP functions. While there has been recent improvement in the City's involvement in SEQRA, **EPA recommends that NYCDEP actively participate at the earliest possible time in the SEQRA planning process by presenting its issues and concerns early, and getting them on the record. EPA recommends that the City bring experienced environmental land use planners (especially planners experienced in the municipal planning process) to planning meetings and presentation sessions and that they actively engage with town planning boards and developers.**

Reduction of impervious surfaces is a key component of good environmental design. Studies have shown that there is an "imperviousness" threshold at which no BMPs can mitigate the additional pollutant load resulting from development.[30] Therefore, if the City is not active in site design and waits to address all environmental concerns through the SPPP, the result will be an SPPP that cannot possibly meet its own objectives. **EPA recommends that NYCDEP make it a priority to work with developers and town planning boards to limit the amount of impervious surfaces and to utilize the natural landscape as buffers.** With good environmental design, the developer can produce a workable SPPP that reduces reliance on structural stormwater controls to mitigate pollutant runoff from a site.

By knowing the level of imperviousness in watershed sub-basins, the City can pinpoint projects and design issues that warrant special attention. Additionally, it could use this information to work with local governments and aid them in identifying areas where the level of imperviousness is approaching a threshold that may cause significant water quality concerns and focusing resources on retrofitting/remediating existing problems. **EPA recommends that NYCDEP map, analyze and track impervious cover in the watershed, particularly in east-of-Hudson sub-basins, and that it make this information available to town and county planners. EPA recommends that the City use information on imperviousness to better evaluate the thresholds at which the water quality impacts from development may be irreparable and to focus resources on retrofitting/remediating existing problems. In addition, EPA recommends that the City support local issues (such as upzoning) that may provide a water quality benefit by reducing impervious surfaces.**

There have been criticisms that "setback" requirements in the WR&R are not effective pollutant barriers (or buffers) in that they do nothing to manage and mitigate runoff between a certain activity and a watercourse. **EPA recommends that the City utilize its authority under SEQRA to work with developers such that "active" buffers are built into a project's design.** This, again, reduces the need to rely solely on structural BMPs to mitigate pollutant runoff.

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[30] See Schueler, T., *The Importance of Imperviousness* (Center for Watershed Protection, 1994)

XIII. Watershed Monitoring Program

1. Program Objectives

The objective of NYCDEP's Watershed Monitoring Program is to provide a characterization of the City's reservoirs and their watersheds in order to effectively guide watershed protection programs and water supply management. In addition, the Program is designed to:

- Support the Filtration Avoidance Determination (FAD), the Watershed Memorandum of Agreement (MOA) and the Watershed Rules & Regulations (WR&R);
- Optimize water quality and quantity through efficient operations;
- Assess compliance with regulatory requirements such as the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA);
- Track water quality problems such as turbidity, algae and bacteria and guide chemical treatment;
- Evaluate long-term water quality trends and develop models;
- Evaluate effectiveness of MOA, WR&R and remedial actions;
- Identify potential pollution sources; and
- Characterize natural and man-made features for planning purposes and assess how potential changes in these features may impact water quality.

These objectives are addressed through a combination of monitoring initiatives which, together, encompass NYCDEP's comprehensive Watershed Monitoring Program.[31]

2. Program Description

The City's Watershed Monitoring Program is divided into three basic groups - routine, specific and pathogen monitoring. Routine sampling consists of fixed frequency surveys to record current conditions and provide a long-term record for trend analysis. Routine sampling provides data that serve as the basis for hydrodynamic and water quality models. It also supplies data for regulatory compliance with the Surface Water Treatment Rule's (SWTR) objective criteria. Specific monitoring programs are more focused initiatives which address specific watershed management issues. These studies compliment the City's routine monitoring program and aid in efforts, required under the SWTR to avoid filtration, to characterize the watershed, identify characteristics that may have an adverse effect on

[31] See *Water Quality Surveillance Monitoring* (NYCDEP, November 19997) and *New York City's Proposed Enhanced Watershed Protection Monitoring Program* (NYCDEP, September 1996) for a complete description of the City's monitoring efforts.

water quality and monitor the activities which may negatively impact water quality. Specific monitoring programs also aid NYC's efforts to evaluate and respond to episodic events, such as algal blooms. Finally, the City's pathogen monitoring program is actually part of routine and specific monitoring programs, but will be described separately below.

A. Routine Monitoring

NYCDEP conducts extensive routine monitoring to establish compliance with the SWTR. **Compliance monitoring** is conducted at source water (raw water) and treated water (after initial chlorination) locations. Source water locations are at the Catskill Lower Effluent Chamber, Delaware Shaft 18, and the Croton Gate House. Treated water sampling points are located at the Catskill Eastview Connection Chamber, Delaware Shaft 19, Croton Shaft 9 and the Croton Gatehouse. At each of these locations, turbidity is monitored continuously and daily grab samples are collected for total and fecal coliform. Daily grab samples (continuous sampling at Catskill Eastview Chamber and Delaware 19) are collected for pH, temperature and free chlorine residual (only at treated water sites).

The objective of the **Aqueduct Keypoint Monitoring Program** is to detect early signs of source water quality changes which may impact the quality of water in the distribution system. Twenty-two sampling locations (including each of the SWTR compliance monitoring locations) at the entrance and exit points of aqueducts allow the City to track the movement of algae, bacteria and turbidity. The City uses this information to make operational decisions regarding routing and treatment. Sampling frequency ranges from daily to semi-annually. Parameters include:

- *Physical*: odor, color, turbidity, temperature, specific conductivity, pH, dissolved oxygen;
- *Chemical*: nutrients, chloride, total organic carbon, major cations, free chlorine, trihalomethanes, mercury; and
- *Biological*: heterotrophic plate count, total and fecal coliform

Reservoir monitoring is conducted monthly, with an additional round of samples taken at the terminal reservoirs (Kensico, Rondout, Ashokan, West Branch, New Croton). These data provide baseline water quality conditions and provide input for models. There are 86 sites throughout the system, typically along the main axis of the reservoir. Samples are taken from multiple depths and are analyzed for physical, chemical and biological parameters.

The City's **stream monitoring** program is used to identify areas of concern, compile the Priority Water Body List, estimate baseline loading for models and evaluate WWTP impacts. Grab samples are collected at 139 locations, including reservoir inflows, sites upstream and downstream of select wastewater treatment plants and town centers, and sub-basin outflows.

Physical, chemical and biological samples are collected twice a month. West-of-Hudson samples are analyzed quarterly for trace metals (Ag, As, Ba, Cd, Cr, Hg, Pb, Se, Zn) and monthly for major cations (Ca, Mg, Na, K, Fe, Mn, Al, Cu). (An exception is Kensico where suspended solids are collected weekly and trace metals and major cations are collected twice a year.)

Several streams are monitored on a routine basis for flow and water quality. Over 65 gauging stations provide continuous flow data used to compile water budgets, relative stream contributions and input to models. Site selection is based on specific data needs, paired upstream and downstream sites and land use. Twenty-five meteorologic stations are located throughout east-of-Hudson and west-of-Hudson watersheds. These stations collect essential data for water budgets and models. Air temperature, relative humidity, rainfall/snow depth, solar radiation, wind speed and soil moisture are collected every 15 minutes.

In accordance with the 1997 FAD, routine monitoring is conducted by NYCDEP at each of the 106 SPDES surface water dischargers. City owned plants are sampled weekly for compliance with NYSDEC SPDES permits. Grab sample monitoring at the non-City owned plants is conducted twice per month to monitor general treatment effectiveness, provide limited enforceable information (settleable solids, fecal coliform and chlorine residual), and provide data for pollutant loading estimates.

B. Specific Monitoring Programs

i. Kensico Study - Due to its role as the Catskill/Delaware system's terminal reservoir, the Kensico Reservoir has been intensively studied. Studies are conducted to meet compliance requirements, demonstrate effectiveness of remedial programs to control non-point sources of pollution, evaluate the impact of storms, quantify loads and transport of pollutants through the reservoir, and develop the Kensico model. Several of the routine and pathogen monitoring sites are located in the Kensico basin (streams, keypoint and compliance monitoring). The Kensico Study also includes avian fecal matter biological analysis, a forest regeneration study, and storm event sampling. (The Kensico Study is further discussed in Chapter V of this report.)

ii. Forest Regeneration Study - NYCDEP is conducting a study to assess the effect white-tailed deer herbivore has on regeneration of forest trees in the Kensico watershed. Forested buffer strips are losing their effectiveness due to the lack of young trees. Seedlings produced do not typically survive beyond one year, apparently due to the feeding habits of the deer. The undergrowth in the buffer strips is becoming dominated by shrubs and vines which are not as effective as trees in protecting water quality. In order to assess survival, 36 seedling plots were installed. Preliminary results suggest that deer have a negative impact on seedling growth. Other factors may play a role in seedling survival such as the protection of seedlings from harsh weather or sun. Forest regrowth also has implications for logged areas in the Catskill/Delaware system.

iii. Storm Monitoring at Streams - Several monitoring efforts have been conducted during storm events in streams throughout the watersheds. In order to provide data for west-of-Hudson models, storm event samples were collected at each west-of-Hudson reservoir for one year. Samples were collected hourly over the length of the storm, beginning at 0.1 inches of rainfall within one hour. Runoff from eight to twelve storms was subject to sampling at each site (12 - 50 samples per event) and analyzed for physical parameters and nutrients.

iv. Turbidity Studies - Turbidity studies have been conducted at streams and reservoirs in the Ashokan and Schoharie basins in the Catskill District to identify turbidity sources. Thousands of grab samples for turbidity and suspended solids were collected at numerous sites in 1993 (663), 1994 (2931), and 1995 (3877). Eighty-nine sites were sampled during the three year period, with sites changing over the course of the study. In 1996, four storm events were sampled at Esopus Creek to provide an estimate of sediment load from upstream sources to Ashokan Reservoir. In addition to monitoring turbidity, these studies included geologic mapping of the Ashokan and Schoharie basins to explore the connection between surficial geology and water quality. At Stony Clove Creek, a 15-mile long tributary to Esopus Creek, turbidity source areas were associated with extensive clay deposits in the stream channel.

Monitoring stations are currently set up in the Schoharie and Ashokan basins to assess management practices to control turbidity. Stations are located above and below stream segments which contribute significant amounts of turbidity. Samples are collected during snowmelt and storm events of varying intensities. Monitoring will continue after management practices are implemented for comparison of stormwater remediation efforts. Biomonitoring is also being conducted to assess turbidity controls. (See Chapter VI.A for a discussion on the City's Stream Management Program.)

Special turbidity monitoring occurs when chemical treatment by alum is needed to control turbidity, typically as a result of storms in the Catskill watershed. Daily testing is required to determine dosage. Keypoint sampling for pH, conductivity, alkalinity, oxygen, color, odor, temperature, total and fecal coliform, turbidity, total/dissolve aluminum is increased to twice a day. Daily samples are collected for *Cryptosporidium* and *Giardia* at the Catskill Lower Effluent Chamber and limnology samples are collected along the Catskill flow line through Kensico Reservoir during the course of treatment.

Reservoir samples are also collected on an ongoing basis to determine the temporal scale and spatial extent of turbidity events, quantify natural vs. man-made sources, calculate mass balance for sediments in reservoirs and determine particle settling rates. NYCDEP conducts limnological sampling during storm events, which are coordinated with stream storm event monitoring to link reservoir levels with sources.

v. Pesticide Monitoring - NYCDEP conducts limited routine pesticide monitoring within the Catskill/Delaware reservoirs. Water and sediment samples have typically been collected in mid-June, based on the assumption that if pesticides were present, they would be most easily detected during this

time period. Two of the sixteen stream sites sampled in 1997 were located in the Kensico basin. In 1998, the Kensico monitoring sites were moved to the source water keypoints. Stream sampling for pesticides during 1998 did not occur outside of the Kensico basin.

vi. Stream Biomonitoring - NYCDEP performs water quality bioassessments throughout the watershed. The main goals of these bioassessments are to:

- develop baseline data sets, particularly in basins targeted for development or remedial activities;
- document the presence of rare or endangered species in order to prevent degradation by upstream land uses; and
- assess the health of those streams potentially impacted by point and non-point source pollution.

Samples are collected annually in August/September at routine hydrology sites and several other sites. Sites were chosen based on:

- the presence (or anticipation) of point source discharges;
- proposed development which could impact stream conditions;
- routine chemical analysis to examine correlations between chemical or bacteriological parameters and the benthic community; and
- streams with a major influence on the receiving reservoir.

Each sample site is assigned to a water quality assessment category: non-impaired, slightly impaired, moderately impaired and severely impaired. This is a relatively new program with about five years of sampling having been conducted. A discussion of the results of the assessments conducted to date can be found in the 1998 FAD Supplemental Report, October 1999.

vii. Enforcement Support and Impact Assessment - These targeted programs, lasting one or two years, provide a legally defensible sampling routine for specific cases of pollution. Examples of past projects include impact assessments of a proposed condominium, golf courses and a horse paddock and sampling of intermittent streams to assess impacts from seasonal WWTP discharges.

viii. Chemical Treatment Monitoring - Chemical treatment monitoring is implemented when operational changes are not sufficient to maintain water quality. When total algae levels exceed 2000 Standard Areal Units (SAUs) or one genus exceeds 1000 SAUs for one week, copper sulfate treatment is initiated. When this occurs, samples are collected twice a day at the treatment tunnel outlet for phytoplankton, turbidity, pH, temperature, conductivity, color, odor, hardness and copper. In the downstream reservoir, samples are collected every three days.

Elevated bacteria or algae levels may be treated by the addition of chlorine in the aqueducts.

Chlorine demand tests are conducted prior to treatment to determine the dose which will result in no chlorine residual at the aqueduct outlet. During treatment, samples are collected for total and fecal coliform, phytoplankton, turbidity, pH, temperature, color, odor, chlorine residual twice per day.

ix. Zebra Mussels - Sixty sites are monitored monthly to provide early detection of zebra mussels. To date, none have been detected. If they are found, monitoring would start to track distribution, identify factors affecting mussels and determine the effectiveness of controls.

x. USGS Contract Studies

Study of Nitrogen Dynamics in the Neversink Watershed.

The objectives of this study are to: (1) determine if forest management can also serve as a tool for nitrogen management, (2) develop a vegetation-based tool to determine hydrologically- sensitive areas and (3) generate data to calibrate and verify water quality models. This is an intensive study to understand the process-level factors of nitrogen saturated soils that impact water quality.

Geologic Framework and Water Resources at Windham

This study documents impacts from seasonal pumping, sewage disposal and road salt storage on groundwater levels and quality. The study evaluated the impact of these ground water issues on surface water flow and chemical characteristics.

C. Pathogen Monitoring

NYCDEP conducts an extensive, watershed-wide Pathogen Monitoring Program for *Cryptosporidium*, *Giardia* and enteric viruses. Over 50 sites are monitored monthly. Source water sites are monitored weekly (increased to daily if turbidity exceeds 1.5 NTUs) and at least one storm event sample is collected per month, if possible. As part of the program, the City samples discharges from sub-watersheds with various land uses (urban, agricultural and undisturbed), sewage treatment plants and areas impacted by wildlife. NYCDEP pathogen sampling began in 1992. To date over 6,000 samples have been collected. These data are used to determine the origins, occurrence, density, transport, fate, distribution and control of pathogens. Pathogen monitoring supports research to improve sampling and analytical techniques, the study fate and transport mechanisms, and the development of pathogen models. Data analysis has begun, and initial results indicate that pathogen occurrence in the watershed is low, but increases during storm events in urbanized streams. A full description of the Pathogen Monitoring Program and results can be found in FAD Task 308e-1, submitted semi-annually.

In addition to watershed-wide monitoring, pathogen monitoring is conducted throughout the watershed to support specific research programs: Kensico Reservoir, Cannonsville Reservoir, farm BMPs, wetlands, sewage treatment plants, the pathogens in stormwater study and the pathogens in wildlife study. Each monitoring site supports several of the objectives of the pathogen monitoring program.

3. Program Assessment

A. FAD Task Compliance

Three direct requirements for monitoring are contained in the FAD. Task 307n-1 requires the City to operate continuously recording flow meters and rain gauges on Kensico tributary creeks. FAD Task 308e-1 requires implementation of *Cryptosporidium*, *Giardia*, and virus monitoring for the entire watershed, the Kensico Reservoir, and for the farm study. Task 312d-1 requires monitoring at all wastewater treatment plants.

The FAD also contains several programs that, by their nature, necessitate monitoring. For example, in order to document its ability to meet the SWTR Objective Criteria, the City must provide monitoring results to EPA monthly. The FAD also requires that models be verified and calibrated, which requires monitoring results. Required research on pathogen loading for future model development is dependent on pathogen monitoring. In addition, monitoring data are necessary to evaluate the Watershed Agricultural Program (a FAD requirement) and to assess the effectiveness of stormwater pollution remediation efforts. NYCDEP continues to meet each of the FAD conditions and reports on monitoring results as required.

B. Implementation Assessment

NYCDEP conducts an intensive monitoring program throughout each of its reservoir basins. Compliance monitoring to meet the SWTR Objective Criteria continues to be sufficient (see Chapter I of this report). The City has effectively utilized data collected through the various monitoring programs to guide research and focus remedial activities and support modeling efforts. For example, the development of the Stream Management Program (Chapter VI.A) and the Kensico Remediation Program (Chapter V) were both influenced by an extensive amount of monitoring data.

In addition, specific monitoring programs have been established by the City to assess the effectiveness of specific remediation programs. For example, the collective management practices on one farm participating in the Watershed Agricultural Program are being evaluated and plans are in place to begin monitoring to evaluate individual management practices (see Chapter IV). Sampling sites have been operating in the Batavia Kill basin to provide baseline data for evaluating the effectiveness of demonstration projects in the Stream Restoration Program (see Chapter VI.A). Focused monitoring efforts in the Kensico basin are planned to assess the effectiveness of stormwater controls being installed. In addition to programs designed to evaluate management practices, several years of monitoring data serve as a baseline of water quality conditions prior to the implementation of management practices, as demonstrated by NYCDEP's ability to utilize its data to assess the Waterfowl Management Program (Chapter IV).

The information collected through the various monitoring programs is also used to support terrestrial and reservoir modeling efforts. These modeling efforts will greatly assist NYCDEP's ability to evaluate programs and predict impacts from future activities. Data needs continue to be identified for improvements in model performance (see Chapter X).

Below, some of the findings of two independent assessments of the City's monitoring program are summarized: one by the International Life Sciences Institute and the other by the National Research Council. A number of monitoring efforts that are being funded under the Safe Drinking Water Act that address many of the concerns raised by those two organizations are also presented. Finally, in the Conclusions/Recommendations Section, EPA's findings and remaining concerns are highlighted.

i. International Life Science Institute (ILSI) Assessment

As part of the MOA negotiations, New York State agreed to fund an independent panel of experts to assess the New York City monitoring program and provide recommendations. This study was conducted through the International Life Sciences Institute (ILSI) and the final report was issued in April of 1998. The ILSI recommendations can be summarized as follows:

Integrated Approach to Watershed Monitoring

- Model Based Watershed Monitoring - To support development of system-wide models to guide collection of information on sources, fate, transport and effects of contaminants. It should also provide information on system-level effects of management actions and strategies. Data and models should be integrated within a GIS system.

- Risk Based Watershed Monitoring - To identify stressors and their risks to public health and ecological systems. The monitoring program should also provide data to assess the effectiveness of management programs to reduce risk.

- Statistical Consideration - A strong statistical design component is needed to ensure that sampling will provide data for situations not covered by models.

Programmatic Recommendations

- Turbidity/Particles/Sediment
  - < Total Suspended Solids should be monitored through the watershed;
  - < Land use changes should be assessed historically and currently;
  - < Sedimentation rates should be evaluated for use in models;
  - < Sediment cores should be collected to assess sedimentation rates, sources and sinks of contaminants and for mass balance studies.

- Pathogens
  - < A process should be in place to identify and use new analytical methods for pathogens;
  - < Legionella, Aeromonas and Salmonella sampling should be discontinued. E. Coli, Clostridium spores and coliphages should be added;
  - < The NYSDOH 60-day travel time should be reconsidered;
  - < Shorelines and groundwater in areas with high concentrations of septic systems should be systematically sampled;
  - < The potential for wildlife, domestic and farm animals to act as pathogen sources should be assessed, as well as the population density of these animals; and
  - < Management practices of biosolids should be examined.

- Eutrophication and THM Precursors
  - < Data should be used to develop eutrophication models; and
  - < Mass balances for organic carbon and phytoplankton carbon should be conducted separately.

ii. National Research Council Assessment

The National Research Council's 1999 report on Watershed Management for New York City also evaluated NYCDEP's monitoring program. The report states that the analytical methods for physical, chemical and pathogen monitoring are generally adequate. It also recognized that the Kensico Reservoir is intensively monitored and that the high level of monitoring should be continued. Recommendations for enhancements to the monitoring program included:

- Event-based or flow proportional monitoring should be conducted, rather than fixed frequency monitoring, for stream, shallow subsurface groundwater, WWTP effluent and precipitation analysis;

- Shallow subsurface and groundwater should be monitored regularly throughout the watershed;

- Monitoring of dissolved organic carbon should be improved;

- NYCDEP should actively participate in the development and use of new and improved methods for pathogen detection;

- Pathogen studies should focus on estimating source terms for various catchments, animals, agricultural and urban activities and farm waste management;

- *E. coli* coliphage, *Clostridium perfringens* and cyanobacteria should be considered for inclusion in routine water quality monitoring;

- Performance monitoring using paired measurements is needed in order to determine the effectiveness of management practices. The Kensico Watershed Remedial Programs, the Phosphorus Offset Program and the Watershed Agricultural Program were identified as examples where performance monitoring is strongly recommended; and

- Monitoring is needed to document the overall effects of the Phosphorus Offset Program on downstream reservoirs.

iii. Enhanced Monitoring

The Safe Drinking Water Act Amendments of 1996, Section 1443, authorizes funding for enhancements to the New York City Watershed monitoring program. NYSDEC receives these funds and has supported several projects which address many of the recommendations made for improvements in monitoring. Over the past three years, the SDWA has provided $5 million which was used to support the following enhancements to monitoring in the watershed.

Point Source Monitoring - All WWTPs with a surface water discharge will be monitored by NYSDEC. This will supplement the quarterly effort by NYCDEP. NYSDEC staff will:

< conduct at least two comprehensive and two reconnaissance inspections per year at the New York City-owned/operated WWTPs and the EPA major WWTPs and conduct comprehensive sampling;

- conduct at least one comprehensive inspection and one reconnaissance inspection per year at the significant WWTPs and conduct comprehensive sampling as needed; and
- conduct at least one comprehensive inspection per year at the non-significant WWTPs and conduct comprehensive sampling as needed.

Non-Point Source Monitoring (Town Brook) - The Town Brook Project is a research study that looks at the landscape-level effects of land use on downstream water quality. Town Brook is located in the West Branch Delaware River Basin, terminating in the Cannonsville Reservoir. The watershed contains several land uses (farming, residential, small-urban, forestry) all of which influence the quality and quantity of runoff in complex ways. As part of this project:

- NYSDEC established and continues to operate a sampling site on Town Brook to study base flow and event-oriented instream nutrient and sediment loads;
- USGS will collect and interpret water quality and quantity data from a multi-use watershed dominated by agriculture and a forested watershed that is nested upstream;
- The Watershed Agricultural Council will study the effectiveness of management practices to minimize phosphorus losses to the Cannonsville Reservoir due to agricultural activities. The studies will evaluate the following:
  - effectiveness of phosphorus immobilizing soil and manure amendments in high phosphorus soils;
  - effectiveness of stream bank fencing and riparian buffers;
  - effectiveness of barnyard improvements alone and in combination with filter strips; and
  - subsurface transport of phosphorus.

Ambient Water Monitoring - NYSDEC will monitor and assess the effects of trace organics and metals, toxics, pesticides and nutrients in the watershed. Sampling will include water column samples, macroinvertebrate and tissue sampling, and sediment core sampling. Water column sites were selected using the probabilistic monitoring approach.

Selected WWTP effluents will undergo toxicity testing. This data will be used to determine where to conduct follow-up toxicity testing and identification.

NYSDEC's Rotating Intensive Basin Study is expanded to include NYC watershed tributaries. Analyses will include water column, bottom and surficial sediment, sediment cores, macroinvertebrate tissue and periphyton monitoring.

EOH Macroinvertebrate Study - Samples of macroinvertebrates and algae will be taken for the presence of pesticides. Sites will be coordinated with fixed station automated samplers to collect pesticide data during storm events.

Pesticide Use Study - The Pesticide Use Study will include a pesticide and fertilizer use survey of homeowners, commercial applicators, commercial (industrial) users and agricultural users East of the Hudson River. The goal of the Study is to document which pesticides and fertilizers are used in the watershed, how much is used and where they are used. The Study will also provide information needed to develop a proposed program for future pesticides monitoring and make recommendations for additional work that may be needed to fill in pesticide use data gaps.

Volunteer Monitoring Program - The Volunteer Monitoring Program will be conducted as part of the NYSDEC *Water Watch* Network to provide a monitoring framework that channels volunteer activities toward producing information useful for program management. Monitoring information/data will be incorporated into the NYSDEC Priority Waterbodies List, the USEPA national water quality database where appropriate, and appropriate New York City Watershed databases.

GIS Enhancements - GIS enhancements will include floodplain mapping in each of the 19 reservoirs, the development of a meteorological database and analytical and visualization tools for snowmelt modeling.

Wetlands Mapping - The wetlands mapping program will review and add up to 40 wetlands and amend boundaries on up to 55 wetlands in five counties in the New York City Watershed consistent with the requirements in Article 24 of the New York State Environmental Conservation Law and 6NYCRR Part 664.

New York City's Ambient Surface Water Program - NYCDEP will complete collection and analysis of up to 720 samples at 8 sites. Sampling will include monthly monitoring and event monitoring for up to 8 storm events within the Croton System watershed to obtain nutrient loading information. The data from this effort will be used to improve the accuracy of the City's TMDL load estimates and assist in evaluating export coefficients used for these calculations.

New York City's Terrestrial Water Quality Monitoring - NYCDEP will formally evaluate its current terrestrial models as to their suitability to accommodate the complexity of the Croton System watershed and meet the management goals. NYCDEP will define objectives for the Croton System terrestrial modeling, conduct initial GWLF model application, and evaluate terrestrial models for use in the Croton System. The engineering and scientific components of other possible models will be considered in an effort to provide guidance to New York City in its selection of appropriate models for TMDL application. Stream gauges and NYCDEP's current GIS and water quality database will be evaluated, and recommendations for further gauging or data collection will be made if needed. The final report will describe monitoring/modeling issues for the Croton System, identify data gaps and prioritize data needs, and suggest future modeling and monitoring efforts.

NYC's Hydrologic Database - NYCDEP will compile, evaluate and digitize (computerize) all critical daily hydrologic data necessary for the development of water budgets for the Croton System reservoirs. These data include: stage, release, spill, inflow, and operations (quantity options) for each reservoir. Data gaps will be identified and addressed. Two new stream gauges will be constructed and operated on the New Croton Reservoir watershed.

NYCDEP Model Testing for East-of-Hudson Reservoirs - This is the initiation of a multi-phase water quality modeling effort for the EOH reservoirs with calibration of a one-dimensional hydrothermal model and a eutrophication model for the Cross River Reservoir.

Delaware County Phosphorus Reduction Demonstration Project - Communities and businesses in the Cannonsville Reservoir basin will be selected to demonstrate the identification and selection of best management options for reducing phosphorus loading in runoff and storm water. The need for runoff and storm water management, and options for such management, will be ascertained using methods of spatially variable assessments and controls.

Delaware County will also conduct a project which monitors and evaluates the effects of precision feed and forage management as part of its Phosphorus Reduction Program.

Stroud Research Center Watershed-wide Monitoring - Stroud Research Center will conduct an integrated watershed-wide monitoring program to address source and ecosystem impairment dynamics. The program will establish a monitoring system to measure the amounts of specific contaminants and determine their sources. The study will also determine the current structure and function of key ecosystem parameters.

Section 552 of the Water Resources Development Act of 1996 established the New York City Watershed Environmental Assistance Program. This program has provided $5 million in funds to be used for implementing water-related environmental infrastructure and resource protection projects in the watershed. A portion of the funds has been used to fund the following enhanced monitoring program.

Evaluation of Stormwater Management Facilities - Design, construct and evaluate pollutant removal efficiencies of four stormwater management facilities, including detention basins with wetlands components.

4. Conclusions/Recommendations

NYCDEP conducts an extensive water quality monitoring program throughout the watershed and each of its reservoir basins. Compliance monitoring to meet the SWTR's Objective Criteria continues to be sufficient. The City utilizes the data collected through the various monitoring programs to guide research, focus remedial activities, and support modeling efforts. Due to its own internal reviews as well as a result of outside assessments (particularly ILSI), the City has significantly enhanced its monitoring program in recent years and continues to plan additional improvements. In addition, NYCDEP's pathogen monitoring program is aggressive in developing, evaluating and implementing new analytical methods and sampling techniques. Below, we have highlighted issues that need to be addressed as the City's watershed protection efforts move from the planning phase and into the implementation and analysis phase.

Trend Analysis

In its Filtration Avoidance Supplemental Report (November 1999), NYCDEP recognized the importance that statistically-based trend analysis will play in assessing the effectiveness of its watershed management programs to maintain or improve water quality. Thus, it is of paramount importance that the City have a monitoring design network (or networks) robust enough to allow the evaluation of multiple programs at the basin and sub-basin scales.

To be effective, the City's watershed-wide monitoring network must be fully integrated with program-specific monitoring and efforts that are underway to quantify reductions in non-point sources resulting from specific management practices. The City's *Filtration Avoidance Supplemental Annual Report* (November 1999) provides a conceptual framework as to the types of tools it plans to use to evaluate

each of its watershed protection programs. For a number of protection programs, the City concludes that the measure of success will be "maintenance of high water quality and consistent compliance with regulations." For remediation programs, the City states that success will be "measured by the degree to which they can reduce loadings from entering the water supply." Although EPA agrees that these are appropriate objectives, the City has not taken the next step - to show that the current system is capable of detecting trends and quantifying pollutant reductions either across watershed protection/remediation programs or within programs. Taking this next step is fundamental to the future of filtration avoidance. **EPA recommends that the City conduct a rigorous analysis of its current monitoring arrays to determine their adequacy to detect trends, and to measure pollutant reductions, within and across watershed programs, at the basin and sub-basin scales. In addition, EPA recommends that the City lay out a specific "roadmap" to show how it intends to utilize these data to measure program success. (This analysis should also include monitoring programs being conducted by other agencies and organizations in the watershed.**) The result of this effort may be an expansion or rearrangement of the City's monitoring program.

Monitoring and Modeling Data Integration/Analysis/Integration

While NYCDEP's monitoring programs are commendable, EPA is concerned with the City's efforts, thus far, to integrate and evaluate data from its various programs. As noted above, models will be one of the key tools that the City uses to evaluate its watershed protection/remediation programs. They will allow the City to run scenarios to estimate the effectiveness of particular programs and their expected impacts on water in the future (e.g., the Watershed Agricultural Program). However, to fully use the models for this purpose, the City must "link" these programs to its Generalized Watershed Loading Function (GWLF) model. As discussed in Chapter X, GWLF's ultimate use as a predictive, watershed management tool will be limited unless the effects of management practices and land use changes can be accurately translated into the runoff and nutrient coefficients used in the GWLF model. **EPA recommends that the City develop a plan for using terrestrial and reservoir models in the watershed to meet program objectives. This plan should ensure the development of accurate runoff and nutrient coefficients for input to the City's terrestrial models, and should provide an enhanced technical basis for future reservoir Total Maximum Daily Loads (TMDLs).**

EPA recognizes that the City collects tremendous amounts of data throughout the watershed. Some of these data have undergone analysis and are presented in FAD Tasks or other reports. However, EPA and other stakeholders receive very little data or data analysis on a number of programs, including the City's stream and reservoir monitoring programs. These monitoring programs form the foundation of NYCDEP's efforts to determine the long-term effectiveness of its watershed protection and remediation programs. **EPA recommends that the City substantially increase its emphasis on data analysis and presentation. EPA recommends that the City develop a comprehensive strategy to integrate, analyze and disseminate the data it collects from its watershed monitoring programs. To facilitate this effort, EPA recommends that the City re-institute its Annual Water Quality Report (last published in 1993) and tailor it to provide analysis that is**

both programmatic and geographic in scope, addressing specific watershed programs and the health of individual reservoir basins.

Increased efforts in data management are necessary as the City's watershed protection program makes the transition from planning and implementation to implementation and analysis. **EPA recommends that NYCDEP fully utilize its Water Quality Information System, Laboratory Information Management System and GIS to compile this information and make it easily available to regulatory agencies, MOA partners and the public.**

Pathogens

In accordance with the SWTR, the City must have a watershed control program that effectively minimizes the potential for source water contamination by pathogens and viruses. Unfortunately, monitoring for pathogens, especially *Cryptosporidium* oocysts, is still a new field of science and methods for detecting oocysts in the environment are relatively unreliable, expensive and time consuming. In addition, the fate and transport of *Cryptosporidium* is not well understood, making it difficult to show how specific management practices and programs will reduce pathogen concentrations. Complicating factors include: uncertainties with respect to the contribution and loading rates from various sources, sorption/desorption mechanisms, infectivity/viability and oocyst die-off.

EPA commends NYCDEP's efforts to date (as well as efforts by partner agency's such as NYSDOH and the Watershed Agricultural Council) in overcoming some of these barriers. NYCDEP conducts extensive pathogen monitoring as well as research efforts to improve its capacity for pathogen monitoring. A study on settling velocities is underway and NYCDEP is actively working on improvements to analytical methods. Much of the research conducted through the Watershed Agricultural Program addressed pathogens. **EPA recommends that NYCDEP continue its work toward improving analytical methods, increasing storm event monitoring for pathogens and conducting *Cryptosporidium* research. Specifically, EPA recommends that NYCDEP develop a pathogen component to the Town Brook Study and coordinate with the Watershed Agricultural Program to include that component in future research. EPA also recommends that NYCDEP continue to evaluate the fate and transport of *Cryptosporidium* to ensure that the City's watershed protection programs are protective of water supply intakes.**

Pesticides

Monitoring to date indicates that pesticides are either detected at very low concentrations or not detected at all in watershed. However, monitoring for pesticides has been infrequent and only at reservoir keypoints. In 1998, monitoring was confined to the Kensico Reservoir. **Although pesticide use information suggests that pesticides are not a major threat to the watershed, EPA recommends that the City conduct additional pesticide monitoring to substantiate that**

pesticides are not a significant water quality concern. EPA recommends that monitoring be conducted consistent with the findings of the Pesticide and Fertilizer Working Group (formed under the Watershed MOA) and the East-of-Hudson Pesticide Use Survey (conducted by NYSDEC with SDWA funds).

XIV. Catskill/Delaware Water Supply System Filtration Plant

1. Program Objective

EPAs's Filtration Avoidance Determination (FAD) for the City's Catskill/Delaware water supply system is based in part on the adequacy of its watershed protection program. Due to uncertainties as to whether the City's watershed protection program would be successful, EPA incorporated into its December 1993 FAD requirements for the preliminary design of filtration facilities for the Catskill/Delaware water supply. This is intended to be a prudent health protection measure which is intended to minimize lost time if EPA later determines that filtration is necessary.

2. Background and Program Description

In December 1993, EPA renewed the City's FAD for its Catskill/Delaware water supply based on EPA's determination that the City continued to meet the objective criteria of the SWTR and that it had an adequate watershed protection program. However, due to uncertainties regarding the long-term effectiveness of the City's watershed protection program, the December 1993 FAD was conditional. It called for continued enhancements to the existing watershed protection program and required the City to immediately proceed with the preliminary design of filtration facilities. This concept of watershed protection with parallel filtration plant design is referred to by EPA as a time neutral or dual-track approach.

With the signing of the Watershed MOA, EPA, in consultation with NYSDOH, issued the 1997 FAD for the City's Catskill/Delaware system. The 1997 FAD incorporated ongoing programs under the December 1993 FAD, as well as new initiatives and obligations. Tasks included the requirement that NYCDEP continue with the dual-track process of implementing a watershed control program and designing a filtration facility (conceptual through final design phase). The FAD also provides NYCDEP an opportunity, prior to the end of the 1997 FAD, to seek relief from the requirement to continue the design effort beyond the preliminary phase based on its ability to demonstrate to EPA substantial compliance with the terms of the FAD.

3. Assessment

A. FAD Task Compliance

Throughout the first half of the 1997 FAD, NYCDEP has complied with the FAD schedule of tasks associated with the design of the Catskill/Delaware Filtration Plant. Key tasks include:

- Recommended siting of the filtration plant and selection of the filtration process (FAD Task 201a-2),
- Completion of Phase II operation of the filtration pilot study (FAD Task 203a-2),
- Revised conceptual design based on results of filtration pilot study (FAD Task 203b-1), and
- Commencement of preliminary design (FAD Task 203b-3)

Progress is monitored through monthly status meetings with the City and its design consultants, and through the City's submittal of quarterly progress reports (FAD Task 200).

B. Implementation Assessment

EPA is satisfied with NYCDEP's design efforts to date. Under the requirements of the State Environmental Quality Review Act (SEQRA) and the City Environmental Quality Review process (CEQR), the City filed a Notice of Lead Agency Declaration, a Positive Declaration and a Draft Scope of Work for the project on December 13, 1999. A public scoping meeting was held on January 26, 2000 at the Westchester County Center to receive comments on the Draft Scope of Work. The Draft Environmental Impact Statement (DEIS) is scheduled for completion at the end of 2000.

In the event EPA requires filtration for the Catskill/Delaware system, NYCDEP proposes to build a filtration plant (1,960 million gallon a day) located on a 150-acre site of City-owned land (the Eastview site), within the Towns of Greenburgh and Mount Pleasant. The proposed site is located above the existing Catskill and Delaware aqueducts south of the Kensico Reservoir and north of the Hillview Reservoir.

In an effort to involve the public early in the planning process, NYCDEP established (April 7, 1999) a Citizen Advisory Committee (CAC) for the project. The CAC meets on a monthly basis and is intended to function as a cooperative but independent advisory body, providing NYCDEP with citizen concerns, questions and information as the planning process proceeds. EPA has attended CAC meetings and recognizes these meetings as crucial to the DEIS process.

4. Conclusions/Recommendations

NYCDEP's design efforts regarding the Catskill/Delaware Filtration Plant are proceeding on schedule. EPA considers the continuation of these efforts to be a prudent measure in the protection of public health. In the event filtration of the Catskill/Delaware supply is deemed necessary, public participation early in the planning process will prove vital to the project's overall success. **EPA, therefore, commends NYCDEP in its public outreach efforts to date through the establishment of the CAC and recommends that it continue the CAC during the second half of the FAD**.

Appendix A - 1999 Annual On-site Inspection Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II

SAFE DRINKING WATER ACT
SURFACE WATER TREATMENT RULE

1999 ANNUAL ON-SITE INSPECTION REPORT

NEW YORK CITY CATSKILL AND DELAWARE WATER SUPPLY SYSTEM

March, 2000

New York City Watershed Team
Division of Environmental Planning & Protection

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United States Environmental Protection Agency
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New York City Catskill and Delaware Water Supply System

I. INTRODUCTION

The federal Surface Water Treatment Rule (SWTR) requires all public water systems supplied by unfiltered surface water sources to meet a series of water quality, disinfection, and site-specific criteria in order to secure and maintain filtration avoidance status. The SWTR requires an annual on-site inspection, conducted by the Primacy Agency, to evaluate the watershed protection program and disinfection facilities. EPA Region II has been charged with evaluation of New York City's (City's) watershed protection program through the May, 1997 Filtration Avoidance Determination (FAD) and must conduct the annual on-site inspection until primacy for the Catskill and Delaware Systems are delegated to the New York State Department of Health (NYSDOH), scheduled for May 15, 2007. The watershed protection program and the annual on-site inspection are inter-related preventive strategies. The main objective of the on-site inspection is to enhance watershed protection by providing direct oversight of source water quality control and disinfection facilities by the Primacy Agency. As defined by EPA, an on-site inspection includes review of the source water monitoring data, disinfection facilities and operation and maintenance of a public water system for the purpose of evaluating the adequacy of such systems for producing safe drinking water. This report sets forth an evaluation of the New York City Catskill and Delaware Water Supply Systems during 1999 which satisfies the requirements for conducting an annual on-site inspection under the SWTR.

II SOURCE EVALUATION

A. Review of effectiveness of the watershed protection program.

The January 21, 1997 signing of the New York City Watershed Memorandum of Agreement (MOA) has allowed the City to make progress on three critical areas of its watershed protection program: (1) promulgation of revised Watershed Rules & Regulations; (2) acquisition of undeveloped environmentally sensitive watershed lands; and (3) partnership programs with watershed communities which include upgrading of wastewater treatment plants discharging in the City's watersheds.

EPA reviews the City's watershed protection program on at least a quarterly basis. In June 1999, EPA completed its review of the New York City Department of Environmental Protection's (NYCDEP's) *Filtration Avoidance Annual Report*, covering the period January 1 through December 31, 1998, submitted in accordance with FAD Task 901a of the FAD. This was the second annual review of the progress of the City's watershed protection program since signing of the MOA and issuance of the 1997 FAD. The reviews (both quarterly and annual) concluded that the City has substantially met its FAD commitments for 1998. By mid-1999, however, it had become apparent that substantial delays were beginning to hamper progress in the wastewater treatment plant upgrade program.

A few significant achievements to date are summarized below:

- **Objective Criteria:** NYCDEP continues to meet all federal and state source water quality objective criteria;
- **Land Acquisition:** Third year FAD solicitation target of 150,608 acres was met and over 18,000 acres were either acquired or under purchase contract;
- **Wastewater Treatment Plant Upgrades:** All owners have signed upgrade agreements and obtained NYCDEP approval of compliance plans and schedules. Engineering proposals currently under review by NYCDEP.
- **Septic System Rehab/Replacement:** Program ongoing with over 820 failed or failing septics repaired or replaced through Catskill Watershed Corporation lead.
- **Watershed Agricultural Program:** The Watershed Agricultural Council (with the City) has approved 229 Whole Farm Plans and has begun implementation on 167 farms, exceeding the FAD goals of 225 and 136, respectively.
- **CAT/DEL Filtration Plant Design:** In accordance with SEQRA/CEQR requirements, NYCDEP has submitted the Notice of Lead Agency Declaration, Positive Declaration and Draft Scope of Work necessary for the development of the Draft EIS. Full scale project design is proceeding on schedule.

- **Kensico Best Management Practices (BMPs):** Although behind schedule, the City completed sediment dredging in front of the Catskill and Delaware Aqueduct intakes and major stormwater BMPs along Malcolm and Young Brooks.

In accordance with the 1997 FAD and the MOA, EPA in consultation with NYSDOH is conducting a formal mid-course review of the City's compliance with the FAD. Unlike the prior quarterly and annual reviews, the mid-course review will be unique in that EPA will solicit public input from all interested stakeholders as it assesses the City's compliance with the terms and conditions of the FAD. The final report will be issued by EPA on or before April 15, 2000. In addition to its FAD commitments for 1998, the City has also submitted a supplemental annual report in November, 1999, which sets out a framework for evaluating the effectiveness of its water supply protection program. This report will aid EPA in its mid-course FAD review.

B. Review of physical condition and protection of the source intakes.

a. Kensico Reservoir

"Influent Chamber" (Catskill Supply): On-site inspection conducted on 16 November 1999. Overall physical condition and protection from contamination was satisfactory. Routine preventative maintenance performed monthly. Receives raw source water from Ashokan Reservoir. Intakes were operating on full flow into the reservoir ("Reservoir Mode") over weirs at time of inspection. No unusual water quality impairments were observed.

"Upper Effluent Chamber" (Catskill Supply): On-site inspection conducted on 16 November 1999. Overall physical condition and protection from contamination was satisfactory. Routine preventative maintenance performed monthly. The lower mechanisms for all operators, main drive shaft and all clutches were rebuilt during 1999.

"Lower Effluent Chamber" (Catskill Supply): On-site inspection conducted on 16 November 1999. Overall physical condition and protection from contamination was satisfactory. Routine preventative maintenance performed monthly. Electric power generation (4000KW) operated and maintained at this location by the New York State Power Authority. A lab room has been dedicated for the collection of water quality samples. This room is equipped for continuous monitoring of turbidity, pH, temperature, flow and was in satisfactory condition and well maintained. Instrumentation received daily calibration. MOSCAD (Motorola Supervisory Control and Data Acquisition) system for the transmission of real time monitoring data offsite is now fully operational.

"Screen/Chlorination Chamber" (Catskill Supply): On-site inspection of facility scheduled for 16 November 1999 was not possible due to ongoing remediation of facility. DEP has hired a contractor to remove hazardous material (ie. lead paint) and address minor deterioration of the concrete effluent weir structure. This work is underway and is approximately 80% complete. DEP reported that contractor activities are expected to be completed by March, 2000.

Once remediation efforts are completed, DEP should maintain housekeeping activities at this location on an acceptable level with all other operating facilities. EPA will perform a final observation of chamber at a later date to verify completion of work and that all outstanding items from previous inspections have been satisfactorily addressed.

Shaft 17" Uptake (Delaware Supply): On-site inspection conducted on 16 November 1999. All existing gate valve operators are scheduled to be replaced with new models free of any hazardous material. A new lab room dedicated to the collection of water quality samples was in good working order. Alum and copper sulfate storage with treatment capability here, although it was reported that treatment at this location has not been necessary in recent years. Receives source water from Rondout Reservoir via West Branch Reservoir. Intakes were operating on full flow into the reservoir ("Reservoir Mode") over weirs at time of inspection. No unusual water quality impairments were observed.

"Shaft 18" Downtake (Delaware Supply): On-site inspection conducted on 16 November 1999. A contractor continues to replace gate valve operators to remove hazardous materials (mercury and PCB) in accordance with OSHA (29 CFR 1910.120) standards at the time of inspection. All existing gate valve operators are scheduled to be replaced with new models free of any hazardous material. Sample monitoring and recording areas also equipped for continuous monitoring of turbidity, pH, temperature, conductivity, and flow and were in satisfactory condition and well maintained. Instrumentation received daily calibration. Facilities for the periodic monitoring of pathogens was also present. MOSCAD system for the transmission of real time monitoring data offsite is now fully operational.

b. Hillview Reservoir

"Uptake #1" (Catskill Supply): On-site inspection conducted on 23 November 1999. Overall physical condition was satisfactory with adequate site protection provided. Caustic soda is added here for pH adjustment and operates year-round. New containment walls for the Caustic Soda storage tanks have been constructed. Disinfection using sodium hypochlorite, on-line since 1996, was not in operation at time of the inspection since pre-disinfection of the reservoir is used only during warm-weather operations. The Uptake was operating on full flow into reservoir ("Reservoir Mode") through

the east basin only. The west basin was out of service due to installation of the buttress wall at time of inspection. The North Conduit, connecting Uptake #1 with Uptake #2, was closed and is considered normal operating practice. No unusual water quality impairments were observed. New sample monitoring and recording station for pH, turbidity, temperature and chlorine residual was installed as part of disinfection enhancements at the chamber and was in good working order. Routine preventative maintenance performed monthly. MOSCAD system for the transmission of real time monitoring data offsite will be online and operational by year end.

"Downtake #1" (Catskill Supply): On-site inspection conducted on 23 November 1999. Overall physical condition was satisfactory with adequate site protection provided. Routine preventative maintenance performed monthly. All gate valves are mechanically operated. The South Conduit, connecting Downtake #1 with Downtake #2, was opened and is considered normal operating practice for the South Conduit. Disinfection using chlorine gas and corrosion control using orthophosphate are performed here. The chlorine cylinder storage area needs better containment and operational / safety upgrades to meet current OSHA (29 CFR 1910.120) (29 CFR 1910.120) standards. A room dedicated solely to the storage and containment of chlorine cylinders must be provided. As stated in section III.A. of this report, DEP reported that contracts for design and construction are now in place. Monitoring for total coliform, E-coli, turbidity, pH, temperature, chlorine residual and flow is performed at this location. The MOSCAD system for the transmission of real time monitoring data offsite is currently being installed.

"Uptake #2" (Delaware Supply): On-site inspection conducted on 23 November 1999. Overall physical condition was satisfactory with adequate site protection provided. Caustic soda added here for pH adjustment operates year-round. Intake operating on full bypass mode through Delaware Bypass aqueduct at time of inspection. Full bypass through the Delaware aqueduct is considered the normal mode of operation. No unusual water quality impairments were observed. Routine preventative maintenance performed monthly. New propane driven emergency generator onsite and is tested bi-weekly. Chlorine residual, turbidity, pH and temperature are continuously monitored. MOSCAD system for the transmission of this monitoring data offsite is currently online and operational.

"Downtake #2" (Delaware Supply): On-site inspection conducted on 23 November 1999. Overall physical condition was satisfactory with adequate site protection provided. All gate valves are hydraulically operated. Disinfection using chlorine gas and orthophosphate addition for corrosion control are performed here. Routine preventative maintenance performed monthly. The chlorine cylinder storage area needs better containment and operational / safety upgrades to meet current OSHA (29 CFR 1910.120) standards. A room dedicated solely to the storage and containment of chlorine cylinders must be provided. As stated in section III.A. of this report, DEP reported that contracts for design and construction are now in place.

"Tunnel #3 Control Chamber": On-site inspection conducted on 23 November 1999. New valve chamber put into service June, 1998, meets current OSHA (29 CFR 1910.120) (29 CFR 1910.120) standards for operation and safety. Sends water to Tunnel #3 chlorination facility and on to Van Cortland Valve Chamber before entry to the distribution system. Routine preventative maintenance performed monthly.

c. Rondout Reservoir

"Intake Structures": On-site inspection conducted on 30 November 1999. Intake structures for Cannonsville, Neversink, and Pepacton Reservoirs source water to the Rondout reservoir were in satisfactory operating condition at time of inspection. Hydroelectric power generation performed at each intake before water enters Rondout reservoir. No unusual water quality impairments were observed.

"Effluent Chamber": On-site inspection conducted on 30 November 1999. Building and outside perimeter was in satisfactory condition with adequate protection from raw source water contamination. Rondout effluent travels via Delaware Aqueduct to the West Branch Reservoir. Chlorine storage/feed rooms on "stand-by" mode with no chlorine stored on-site. System is kept under pressure with nitrogen gas as a preventative maintenance measure to assure proper operation if treatment becomes necessary. Copper sulfate treatment capability was also on "standby mode" to be activated if algae control becomes necessary. Treatment at this location by either process has not been necessary since 1996 according to data records provided during the inspection. No unusual water quality impairments were observed. Emergency power generator onsite and is tested weekly under load. Fuel for emergency generator is stored in a double-walled tank.

d. Ashokan Reservoir

"Upper Gate House": On-site inspection conducted on 18 November 1999. Located at the dividing weir which separates the east and west basins. Serves as flow control and rough bar screen structure as the Catskill raw water source transfers from the west basin to the east basin through 16' sluice gates and 8' main gate valves. The overall condition of the structure and protection for contamination of source water well maintained. Currently no backup power supply provided. In the event of a power failure all valves would have to be manually operated. Future plans call for the installation of emergency power generation facilities. No unusual water quality impairments were observed.

"Lower Gate House": On-site inspection conducted on 18 November 1999. Serves primarily as the Ashokan Hydroelectric Power Plant producing 4700 KW under supervision of the New York State Power Authority. Facility in satisfactory condition and well maintained with adequate protection from contamination of the raw water supply. Manned 24 hours per day.

"Screen Chamber": On-site inspection conducted on 18 November 1999. Contains four automated screen racks which filter out debris prior to entering the Catskill aqueduct to Kensico. Since the Ashokan reservoir has the potential to be a terminal reservoir, facility is equipped with chlorine disinfection and copper sulfate treatment (algae control) capability. Neither chlorine or copper sulfate are currently stored onsite. NYCDEP reported that this facility has not been used in a treatment capacity in recent years. Emergency power generator was reported to be in good working order and is tested on a monthly basis.

"Monitoring Building": Monitoring for turbidity, conductivity, pH, temperature, and oxidation reduction potential (ORP) performed here on a continuous basis. Pathogen monitoring conducted once per month. Limnological monitoring as well as pathogen monitoring conducted at selected sites within the Ashokan reservoir. Although chlorine is not currently monitored, instrumentation to measure chlorine residual is present. Real time monitoring data is transmitted offsite via infra red telemetry. This information can also be obtained through the telephone utilizing a dedicated phone line and a data logger.

e. West Branch Reservoir

Uptake Chamber "Shaft 9": On-site inspection conducted on 2 December 1999. Six gate valves exist in which 3 direct flow to the reservoir and 3 direct flow through the bypass aqueduct down to the Shaft 10 forebay before continuing down to the Kensico reservoir. The gate valve operators containing mercury seals and PCB oil are scheduled to be replaced in the future under the Shaft 17 valve replacement contracts. The intake structure was on bypass mode at the time of inspection to allow spillway work to be performed on the dam. No unusual water quality impairments were observed. Monitoring is performed here for pH, turbidity, and conductivity and was in good working order at time of the inspection. Monitoring equipment checked/re-calibrated 1/wk by lab personnel.

Downtake Chamber "Shaft 10": On-site inspection conducted on 2 December 1999. The gate valve operators containing mercury seals and PCB oil are scheduled to be replaced in the future under the Shaft 17 valve replacement contracts. Monitoring equipment was shut down at the time of inspection due to low water elevation in the forebay causing sample pump to shut down. Operating on float mode at time of inspection due to spillway work being performed at the dam. A machine shop is located inside the chamber in which many parts are repaired and/or manufactured for maintenance activities conducted on the water supply system. The machine shop area needs better housekeeping to protect the forebay from the potential for contamination of hazardous materials. For the long-term, a dedicated machine shop facility should be set-up at a location separate from water supply facilities.

f. Boyds Corner Reservoir

On-site inspection conducted on 2 December 1999. Source water feed to Delaware System northwest of West Branch Reservoir. New dam and spillway structure completed over the last two years to meet current New York State regulations. Reservoir is located in a densely wooded area with few residential properties in the vicinity. We note that the NYCDEP has acquired a significant amount of vacant land in this area per the Land Acquisition Program. No unusual water quality impairments were observed on route to West Branch Reservoir.

g. Distribution System Entry Points

Tunnel #1 "Shaft 7" (Catskill): On-site inspection conducted on 23 November 1999. Overall condition of shaft was fair. Treated water supply entry point was adequately protected from contamination; however, chamber shows evidence of damp conditions and storm water infiltration (flooding) into shaft. Dehumidifiers were installed since last inspection to address dampness. A mechanical gate valve was observed leaking water out of center valve stem into the shaft chamber. Due to evidence of the entire valve casing covered in rust, it appears that the valve has been in disrepair for some time. No contamination of the water supply is resulting from the leak but the valve should be repaired as soon as possible for water conservation purposes. New moisture-proof sample monitoring and recording equipment for chlorine residual, turbidity, pH, and temperature was in proper operating condition at time of inspection. Staff inspect and report daily for CT compliance (the SWTR defines CT as the product of residual disinfectant concentration(s) in mg/L and the contact time(s) in minutes). MOSCAD system was recently installed and is now online and operational providing real time monitoring data offsite. We note that access to the shaft via Major Deegan Expressway is hazardous for NYCDEP personnel who visit the site daily, also in the event of an emergency, traffic congestion on the Major Deegan Expressway may delay response of NYCDEP personnel. Improved access to the shaft via Sedgewick Avenue is recommended.

Tunnel #2 "Shaft 3A" (Delaware): On-site inspection conducted on 23 November 1999. Overall condition of shaft was fair. Treated water supply entry point was adequately protected from contamination; however, chamber shows evidence of damp conditions and storm water infiltration (flooding) into shaft. Dehumidifiers were installed since last inspection to address damp conditions. New moisture-proof sample monitoring and recording equipment for chlorine residual, turbidity, pH, and temperature was in proper operating condition at time of inspection. Future plans call for a MOSCAD system to transmit this real time monitoring data offsite. Presently this data is transmitted to Hillview Reservoir (Downtake #2 Control Building) using a basic telemetry signal, dedicated phone line and data logger. Staff inspect and report daily for CT compliance. We note that surface perimeter of shaft location should be better secured to ensure safety of NYCDEP operators and lab personnel. We recommend that better security lighting and fencing around perimeter of shaft entry should be installed to ensure safety of NYCDEP personnel visiting site during night time hours.

Tunnel #3 "Shaft 3B"(Catskill/Delaware): On-site inspection conducted on 23 November 1999. New facility in excellent condition and adequately protected from contamination. Shaft adequately sealed from outside infiltration. Sample monitoring and recording equipment for chlorine residual, turbidity, pH, and temperature was in proper operating condition at time of inspection. Future plans call for a MOSCAD system to transmit this real time monitoring data offsite. Presently this data is transmitted to Hillview (Downtake #2 Control Building) using a basic telemetry signal, dedicated phone line and data logger. Staff inspect and report daily for CT compliance. We recommend that better security lighting and fencing around perimeter of shaft entry should be installed to ensure safety of NYCDEP personnel visiting site during night time hours.

C. Review of condition & maintenance program of disinfection equipment to insure reliability.

a. Kensico Reservoir Chlorination Facilities

"Screen/Chlorination Chamber" (Catskill): On-site inspection conducted on 16 November 1999. Chlorine gas via "Shaft 18" dosed in effluent weir chamber through injection diffusers. Overall operating condition satisfactory. NYCDEP lab staff inspect daily, routine preventative maintenance performed monthly; back-up power generator tested weekly.

"Shaft 18" Downtake (Delaware): On-site inspection conducted on 16 November 1999. Liquid chlorine stored on site in two (2) 1 ton cylinders in service and two (2) back-up. Six (6) liquid to gas vaporizers feed chlorinators providing chlorine gas to both Delaware and Catskill water supply system were in good working order. Five (5) units in operation and one (1) on standby during normal operation. NYCDEP lab staff inspect daily; routine preventative maintenance performed monthly; all

units rebuilt annually. It was reported that chlorine storage room will be upgraded in the future to include air scrubbers and other OSHA (29 CFR 1910.120) operational/safety improvements. As stated in section III.A. of this report, DEP reported that contracts for design and construction are now in place. Back-up power generator tested weekly.

b. Hillview Reservoir Chlorination Facilities

"Downtake #1" (Catskill): On-site inspection conducted on 23 November 1999. Liquid chlorine gas stored on site with two (2) 1 ton cylinders in service and two (2) back-up. Six (6) liquid to gas vaporizers feed chlorinators providing chlorine gas to the Catskill water supply system were in good working order. Three (3) units in operation and three (3) on standby during normal operation. Three (3) chlorine feedwater pumps are present, two (2) are used on a continuous basis, one (1) is on standby. NYCDEP lab staff inspect daily; routine preventative maintenance performed monthly; all units rebuilt annually. Back-up power generator tested weekly.

A room dedicated to the storage of chlorine cylinders incorporating operational/safety improvements to meet current OSHA (29 CFR 1910.120) health/safety standards must be provided. As stated in section III.A. of this report, DEP reported that contracts for design and construction are now in place.

"Downtake #2" (Delaware): On-site inspection conducted 23 November 1999. Liquid chlorine gas stored on site with two (2) 1 ton cylinders in service and two (2) back-up. Three (3) liquid to gas vaporizers feed chlorinators providing chlorine gas to the Delaware supply were in good working order. One (1) unit is in operation and two (2) are on standby during normal operation as was observed during this inspection. DEP lab staff inspect daily; routine preventative maintenance performed monthly; all units rebuilt annually. Back-up power generator tested weekly. A room dedicated to the storage of chlorine cylinders incorporating operational/safety improvements to meet current OSHA (29 CFR 1910.120) health/safety standards must be provided. As stated in section III.A. of this report, DEP reported that contracts for design and construction are now in place.

"Tunnel #3 Chlorination Facility"(Catskill/Delaware): On-site inspection conducted 23 November 1999. New facility put into service 6/98 meets all current operational and health/safety standards. Injects sodium hypochlorite solution contained in three (3) storage tanks. One (1) in service and two (2) on standby. Back-up power generator tested weekly.

c. Ashokan Reservoir Chlorination Facilities

"Screen Chamber" (Catskill): On-site inspection conducted on 18 November 1999.

Chlorine storage room in satisfactory condition though no liquid chlorine cylinders are stored here. DEP reported that liquid chlorine would be provided by contracted supplier upon request within one (1) day. Chlorination room contains three (3) liquid chlorine vaporizers and three (3) gas chlorinators / injectors in satisfactory condition. As part of the NYCDEP's preventative maintenance program, the disinfection system is kept under constant pressure with nitrogen gas during stand-by to prevent corrosion that may result in chlorine leaks. Facility has copper sulfate treatment capability to control algae growth if necessary.

d. Rondout Reservoir Chlorination Facilities

"Effluent Chamber" (Delaware): On-site inspection conducted on 30 November 1999. Chlorine storage room in satisfactory condition though no liquid chlorine cylinders are stored here. DEP reported that liquid chlorine would be provided by contracted supplier upon request within one (1) day. Chlorination room contains three (3) liquid chlorine vaporizers and three (3) gas chlorinators/injectors in satisfactory condition.

As part of the NYCDEP's preventative maintenance program, the disinfection system is kept under constant pressure with nitrogen gas during stand-by to prevent corrosion that may result in chlorine leaks. Facility has copper sulfate treatment capability to control algae growth if necessary and stores copper sulfate onsite (50 drums at 50 lbs each).

e. West Branch Reservoir Chlorination Facilities

Downtake Chamber "Shaft 10"(Delaware): On-site inspection conducted on 2 December 1999. Twelve (12) 1-ton liquid chlorine cylinders are stored on-site. Chlorination room contains two (2) chlorine gas vaporizers (under rehabilitation at time of inspection) and 3 chlorine gas chlorinators and injectors in satisfactory condition. As part of the NYCDEP's preventative maintenance program, the disinfection system is kept under constant pressure with nitrogen gas during stand-by to prevent corrosion that may result in chlorine leaks. No copper sulfate treatment is performed at this location.

f. Redundancy of Disinfection Systems

All disinfection facilities demonstrated adequate redundancy to ensure uninterrupted operation. Adequate back-up emergency power generation provided, tested weekly, and well maintained.

III. TREATMENT EVALUATION

A. Review of improvements and/or additions to disinfection processes during the previous year to correct deficiencies detected in earlier surveys.

Five (5) deficiencies and/or recommendations for improvement were identified in our previous 1998 annual inspection report. The NYCDEP provided a detailed status of the City's efforts to address the deficiencies and/or recommendations in a response letter of October 28, 1999. Our review concludes that all deficiencies and/or recommendations are being satisfactorily addressed as summarized below:

1.) Upgrading of chlorination storage facilities at Hillview Downtake #1, Hillview Downtake #2 and Kensico Shaft 18 to meet current OSHA (29 CFR 1910.120) (29 CFR 1910.120) health and safety standards is necessary.

DEP Response: DEP has awarded a design and construction contract to address the recommended improvements at Shaft 18. Contract work has commenced.

The contract will result in installation of a new chlorination system, including evaporators, chlorinators, injectors, chlorine scales, service pumps and associated piping. At Hillview Reservoir, NYCDEP has entered into a contract for the design of a new chemical addition facility that will replace the existing facilities at Downtakes #1 and #2. In addition, NYCDEP is investigating the feasibility of installing a chlorine scrubber system at the existing facilities. EPA supports this effort.

2.) Improvements to protection of distribution entry point shafts 3A and 7 are needed to correct structural integrity, adequately isolate the automated sampling and recording equipment from dampness (ie. in moisture-proof room), and adequately protect shaft from outside storm water infiltration (flooding of shaft).

DEP Response: All continuous monitoring equipment within these locations are designed to withstand high humidity and damp environments. The instrumentation is routinely checked and calibrated and has been able to operate under the existing conditions within the shafts (Note: During the November EPA inspections, portable dehumidifiers were also observed in the shafts which were not present at the previous inspection.). Chronic breakdowns of instrumentation reported during 1996 were addressed through the upgrade of the instrumentation and reorganization of the downstate Process Control-Remote Monitoring (PC-RM) unit, which is responsible for maintaining the equipment. Malfunctions of data conveyance/telemetering via telephone lines has been resolved by installing a data logger which stores data for retrieval at a later time. Long range plans call for a system-wide upgrade of the existing telemetry system to prevent recurrence of malfunctions.

3.) Continue gate valve replacement at Shaft 17 & 18 to remove potential for hazardous material (mercury, PCB) contamination.

DEP Response: DEP has a contract to remove all sluice gate operators at Shaft 18, which may be contaminated with mercury and PCBs. This remediation effort is underway, with approximately eleven operators removed to date. In addition, DEP has awarded a contract to replace all the sluice gates, after the operators have been removed which is scheduled to start by the end of 1999. The Scope of Work to remove additional sluice gate operators at Shaft 17 has been developed by DEP and a contract is being prepared.

4.) Continue chamber remediation activities at the Catskill Screen/Chlorination chamber to remove hazardous material (lead paint) from the walls. Improve overall housekeeping activities within the Catskill Screen/Chlorination chamber. Attention is needed in the near future to address some minor deterioration of concrete occurring in the weir chamber.

DEP Response: DEP has hired a contractor to remove hazardous material from the Catskill Screen Chamber. This work is underway and is approximately 80% complete.
Once remediation efforts are completed, DEP will maintain housekeeping activities at this chamber on an equal level with all other operating facilities. In addition, DEP will address the minor deterioration of the concrete weir structure. [EPA will perform a final observation of chamber to verify completion of work and that all outstanding items have been satisfactorily addressed.]

5.) Continue to improve perimeter security (access control) of source intakes and disinfection facilities.

DEP Response: DEP has undertaken a number of steps to address this recommendation. Scopes of Work have been drafted for security improvements at Shafts 9, 10, 17. Fencing to the waterline on either side of the building and motion detection security lighting with delayed timer around fence perimeters is planned for Shaft 9, 10, and 17. In addition, intrusion alarms for doors and windows with alert links to local and DEP police is planned for Shaft 17. Other security improvements such as perimeter security lighting, and/or security fencing, and/or intrusion alarms are planned at Ben Nesin Lab; Delaware Aqueduct Shafts 9, 10, 11, 13, 17, 18, 19, and 23; Kensico Catskill Influent Chamber; Kensico Catskill Screen Chamber; Kensico & Pleasantville Meter Chamber; Kensico Upper Effluent Chamber; New Croton Aqueduct 11C, 13, and 17 ½; and Kensico Lower Effluent Chamber. These improvements are in the planning stages and are not included in any current contract. However, DEP hired a security consultant to recommend electronic monitoring and surveillance equipment for the purpose of securing the City's water supply system. DEP received a report in July, 1999, from the

consultant and is in the process of reviewing these recommendations in order to determine necessary future measures.

B. Review of condition & maintenance program of monitoring equipment for CT compliance.

Eastview Monitoring Station (monitoring of treated Catskill supply): Inspection conducted on 16 November 1999. Condition of and maintenance program for sample monitoring and recording equipment was satisfactory at time of inspection. NYCDEP lab staff visit daily to check/re-calibrate equipment and record turbidity, pH, temperature, chlorine residual. Continuous flow chart recorders located at Shaft 18 in good working order. Results are reported back to lab daily for contact time (CT) and inactivation ratio (I/R) analysis.

Kensico "Shaft 19" (monitoring of treated Delaware supply): Inspection conducted on 16 November 1999. Condition of and maintenance program for sample monitoring and recording equipment was satisfactory at time of inspection. NYCDEP lab staff visit daily to check/re-calibrate equipment and record turbidity, pH, temperature, chlorine residual. Continuous flow chart recorders located at Shaft 18 in good working order. Results are reported back to lab daily for CT and I/R analysis.

Hillview "Uptake #1" (monitoring of treated Catskill supply): Inspection conducted on 23 November 1999. Condition of and maintenance program for sample monitoring and recording equipment was satisfactory at time of inspection. NYCDEP lab staff visit daily to check/re-calibrate equipment and record turbidity, pH, temperature, chlorine residual. Continuous flow chart recorders in good working order. Results are reported back to lab daily for CT and I/R analysis.

Hillview "Uptake #2" (monitoring of treated Delaware supply): Inspection conducted on 23 November 1999. Condition of and maintenance program for sample monitoring and recording equipment was satisfactory at time of inspection. NYCDEP Laboratory staff visit daily to check/re-calibrate equipment and record turbidity, pH, temperature, chlorine residual. Continuous flow chart recorders were in good working order at time of inspection. Results are reported back to lab daily for CT and I/R analysis.

Distribution Entry Point "Shaft #7" (Catskill -Tunnel #1): Inspected on 23 November 1999. Automatic sample monitoring and recording equipment was in satisfactory operating condition at time of inspection. However, damp conditions and potential for excessive storm water infiltration is not an ideal environment for this equipment. It was noted that equipment malfunctions have occurred in the past. When this occurs, manual operation is necessary. NYCDEP also plans to address this longstanding issue with a system-wide upgrade of the telemetry system. DEP lab staff visit Shaft #7 daily to check/re-calibrate equipment and record turbidity, pH, temperature, chlorine residual. Continuous flow chart recorders are also used. These results are reported to the lab daily for CT and I/R analysis. The value of the chlorine residual recorded at Shaft #7 serves as the entry point chlorine residual for Tunnel #1.

Distribution Entry Point "Shaft #3A" (Delaware - Tunnel #2): Inspected on 23 November 1999. Automatic sample monitoring and recording equipment was in satisfactory operating condition at time of inspection. Full MOSCAD capability is planned. Presently, real time monitoring data is available via a data logger and dedicated phone line. However, damp conditions and potential for excessive storm water infiltration is not an ideal environment for the equipment. It was noted that equipment malfunctions have occurred in the past. When this occurs, manual operation is necessary. NYCDEP also plans to address this longstanding issue with a system-wide upgrade of the telemetry system. NYCDEP lab staff visit Shaft #3A daily to check/re-calibrate equipment and record turbidity, pH, temperature, chlorine residual. Continuous flow monitoring/chart recorders are also used. These results are reported to the lab daily for CT and I/R analysis. The value of the chlorine residual recorded at Shaft #3A serves as the entry point chlorine residual for Tunnel #2.

Distribution Entry Point "Shaft #3B" (Tunnel #3): Inspected on 23 November 1999. New sample monitoring and recording equipment was found to be in excellent operating condition. Full MOSCAD capability is planned. Presently, real time monitoring data is available via a data logger and dedicated phone line. NYCDEP lab staff visit daily to check/re-calibrate equipment and record turbidity, pH, temperature, chlorine residual. Continuous flow chart recorders in good working order at time of inspection. These results are reported to the lab daily for CT and I/R analysis. The value of the chlorine residual recorded at Shaft #3B serves as the entry point chlorine residual for Tunnel #3.

C. Review of source water reservoir operating procedures.

a. Kensico Reservoir Operations

Catskill System: On-site inspection conducted on 16 November 1999. Between 1/1/99 - 9/15/99, the system was reported to be on Reservoir Mode (full flow into and out of Kensico Reservoir). From 4:00 P.M. to 6:00 P.M. on 9/16/99, the system was put on Float Mode to prepare for tropical storm

Floyd. This resulted in a blending of water from Ashokan Reservoir (Ashokan Effluent Chamber) and Kensico Reservoir (Upper Catskill Effluent Chamber). Starting 6:00 P.M. on 9/16/99 and ending 1:00 P.M. on 9/17/99, the system was on Bypass Mode drawing water directly from the Ashokan Reservoir (Ashokan Effluent Chamber) only. The Bypass Mode was necessary for the duration of tropical storm Floyd. From 1:00 P.M. to 3:00 P.M. on 9/17/99, after the storm passed, the system was returned to Float Mode. For the remainder of the year, 9/17/99 - 12/31/99, the system was operating in Reservoir Mode. As a result of tropical storm Floyd, turbidity measurements in Kensico Reservoir at a depth of 50 ft. were reported as 6.5 NTU at 11:00 P.M. on 9/16/99 dropping to 0.8 NTU at 7:30 A.M. on 9/17/99. No other unusual water quality impairments were reported during the year.

Delaware System: On-site inspection conducted on 16 November 1999. From 1/1/99 - 9/16/99, the system was reported to be on Reservoir Mode. From 8:00 A.M. - 1:30 P.M. on 9/16/99, the system was on Float Mode. This resulted in a blending of water from West Branch Reservoir (Shaft #10) and Kensico Reservoir (Shaft #18) to prepare for tropical storm Floyd. For the remainder of the year, 1:30 P.M. on 9/16/99 through 12/31/99, the system returned to Reservoir Mode. The Cross River, Croton Falls, and Chelsea pump stations were not used during 1999. Except for impacts for tropical storm Floyd as noted for Kensico reservoir above, no other unusual water quality problems were reported during the year.

b. Hillview Reservoir Operations

On-site inspection conducted on 23 November 1999. During normal operation and at time of inspection, the North Connecting Conduit was closed; the South Connecting Conduit was open. The Delaware by-pass aqueduct was in operation between Uptake #2 and Downtake #2 for the entire year and is normal operating practice. The West Basin was placed offline since September 1999 for buttress wall installation activities; thus, the Catskill Aqueduct was open only to the East Basin during the inspection. The Catskill by-pass aqueduct (inside dividing wall) was off-line the entire year due to the temporary dividing wall stabilization (well-point) system being in place for Hillview Reservoir wall stabilization activities.

c. West Branch Reservoir Operations

On-site inspection conducted on 2 December 1999. It was reported that West Branch Reservoir was not a sole raw water source through the Kensico Delaware By-Pass aqueduct to Hillview during 1999. West Branch Reservoir was in Float Mode from 9/1/99 - 9/13/99, Reservoir Mode from 9/13/99 - 9/15/99 for a Rondout Reservoir Flow Test, and returned to Float Mode on 9/15/99. At 7:55 P.M. on 9/16/99 to 10/15/99, West Branch Reservoir was put on Bypass Mode as a result of tropical storm Floyd. Except for impacts for tropical storm Floyd as noted for Kensico Reservoir above, no other unusual water quality problems were reported during the year.

d. Ashokan Reservoir Operations

On-site inspection conducted on 18 November 1999. As noted above, Ashokan Reservoir was a sole raw water source through the Kensico Catskill By-Pass aqueduct to Hillview from 6:00 P.M. on 9/16/99 to 1:00 P.M. on 9/17/99 during tropical storm Floyd. Except for impacts from tropical storm Floyd as noted for Kensico Reservoir above, no other unusual water quality problems were reported during the year.

e. Rondout Reservoir Operations

On-site inspection conducted on 30 November 1999. It was reported that Rondout Reservoir was not a sole raw water source through the Delaware By-Pass aqueducts to Hillview during 1999. From 7:55 P.M. on 9/16/99 to 10/15/99, Rondout Reservoir was a sole raw water source to Kensico Reservoir as a result of bypassing West Branch Reservoir in preparation for tropical storm Floyd. Except for impacts for tropical storm Floyd as noted for Kensico Reservoir above, no other unusual water quality problems were reported during the year.

D. Review of data records to assure required tests are being conducted and recorded, CT calculations are done correctly, and disinfection is effectively practiced.

Raw Water Fecal Coliform Concentrations

Daily raw water grab sample monitoring for fecal coliform conducted at Delaware - Shaft 18 and at the Catskill Lower Effluent Chamber including days turbidity exceeds 1 NTU. Results recorded daily as indicated in staff log book. To comply as an unfiltered raw water source, the Catskill and Delaware water supply systems must exhibit fecal coliform concentrations of no greater than 20 cfu/100 ml in 90% of samples collected prior to disinfection in the previous 6 months of water service to the public. Based on review of data records submitted to EPA, the system met the requirements for raw water fecal coliform compliance in 1999. See attached data table.

Raw Water Turbidity

Continuous raw water turbidity monitoring is conducted at Delaware - Shaft 18 and at the Catskill Lower Effluent Chamber. Readings recorded daily every 4 hours as indicated in staff log book. To comply as an unfiltered raw water source, the Catskill and Delaware water supply systems must exhibit turbidity levels no greater than 5.0 NTU prior to disinfection on a continuous basis. Based on review of

data records submitted to EPA, the system met the requirements for raw water turbidity compliance for the entire year in 1999.

Raw Water Disinfection/CT Values

DEP lab Staff receive treated water data daily for input into computer software application. Staff keypunch in daily peak flow with corresponding data for pH, temperature, and chlorine residual to calculate CT compliance and corresponding I/R. To comply, the system must net a daily I/R of no less than 1.0. Based on review of data records submitted to EPA, the Delaware and Catskill systems satisfied the CT requirements and netted I/R's greater than or equal to 1.0 at all times during 1999 and therefore achieved effective disinfection.

Entry Point Chlorine Residual

Sample monitoring and recording conducted every 4 hrs. daily. Based on review of records, the Delaware and Catskill systems met or exceeded the minimum entry point chlorine residual of 0.2 mg/L for the entire year in 1999.

Distribution System Disinfection Residuals

Based on review of data records submitted to EPA, there was adequate disinfection residuals throughout the distribution system for the entire year in 1999. Note: where chlorine residuals are reported to be zero (0), heterotrophic plate count (HPC) bacteria of <500 HPC/ml are considered equivalent to sites with detectable residuals for purposes of determining compliance. Based on review of data records, all HPC values were reported <500 HPC/ml; therefore adequate disinfection was maintained.

Trihalomethane Monitoring in the Distribution System

The regulation in effect during 1998 requires a Maximum Contaminant Level (MCL) for Total Trihalomethane (TTHM) of 0.10 mg/L (or 100 ug/L) for systems serving a population greater than 10,000. The Stage 1 Disinfection By-Products Rule, promulgated December 1998, will require systems serving a population of greater than 10,000 to meet an MCL for TTHM of 0.080 mg/L (or 80 ug/L) by December 2001. To comply, the system must not exceed the MCL based on a 12-month

running annual average of quarterly samples. Based on review of data records submitted to EPA, the DEP samples for TTHM in the distribution system has met the MCL requirement for TTHM compliance in 1999. The system's 12-month running annual averages of quarterly samples reported for the year are summarized below:

The 1st Quarter 1999 was reported as 34 ug/L.
The 2nd Quarter 1999 was reported as 35 ug/L.
The 3rd Quarter 1999 was reported as 32 ug/L.
The 4th Quarter 1999 was reported as 33 ug/L.

Total Coliform Monitoring in the Distribution System

The Total Coliform Rule established an MCL for total coliform of no more than 5% of 40 or more samples collected during a month testing total coliform-positive. Additional samples are to be collected when the system's turbidity level exceeds 1 NTU in a particular month. To comply, the system must not exceed the MCL for 11 months of the 12 previous months of water service to the public. Based on review of data records submitted to EPA, the system has met the MCL requirements for total coliform compliance for 1999. The monthly results reported for the year are summarized below:

Jan: 980 samples collected; one (1) sample (or 0.1 %) tested positive; all re-samples negative
Feb: 882 samples collected ; no (0) samples (or 0 %) tested positive; all re-samples negative
Mar: 987 samples collected; one (1) sample (or 0.1 %) tested positive; all re-samples negative
Apr: 940 samples collected; one (1) sample (or 0.1 %) tested positive; all re-samples negative
May: 940 samples collected; no (0) samples (or 0 %) tested positive; all re-samples negative
Jun: 951 samples collected; three (3) samples (or 0.3 %) tested positive; all re-samples negative
Jul: 998 samples collected; four (4) samples (or 0.4 %) tested positive; all re-samples negative
Aug: 960 samples collected; two (2) samples (or 0.2 %) tested positive; all re-samples negative
Sep: 972 samples collected; ten (10) samples (or 1.0 %) tested positive; all re-samples negative
Oct: 959 samples collected; two (2) samples (or 0.2 %) tested positive; all re-samples negative
Nov: 897 samples collected; one (1) sample (or 0.1 %) tested positive; all re-samples negative
Dec: 923 samples collected; one (1) sample (or 0.1 %) tested positive; all re-samples negative

Kensico Reservoir Watershed Pathogen Monitoring

The City submits weekly source water monitoring data for *Giardia* and *Cryptosporidium* since January 1993 as required by the FAD. As part of the enhanced monitoring program, the City takes additional daily samples when the turbidity exceeds 1.5 NTU; resources permitting. The sites monitored include the Catskill Alum Plant, Catskill Lower Effluent Chamber, Delaware Shaft 17, Delaware Shaft 18, and Malcolm Brook. Sampling results are submitted monthly to EPA. Based on review of the source water data (see attached summary table), there were three (3) confirmed positive samples for *Giardia* and two (2) confirmed positive samples for *Cyrptosporidium* at the Catskill Lower Effluent Chamber. At Delaware Shaft 18, there were two (2) confirmed positive samples for *Giardia* and zero (0) confirmed positive samples for *Cyrptosporidium* during 1999. NYC should implement Method 1623 for *Giardia* and *Cryptosporidium*, which is what is being used by Public Water Supplies under the supplemental ICR survey.

E. Summary of needed improvements in the equipment, system maintenance and operation, or data collection.

a. Continue to implement design and construction of new chemical feed facilities for Hillview reservoir and address OSHA health & safety issues in the long term.

b. At Shaft 10 Downtake Chamber, correct monitoring pump location in forebay to prevent chronic interruptions of sample monitoring equipment which is occurring due to drop in water elevations below the pump suction lines. Improve housekeeping in and around machine shop area to protect the forebay from the potential for contamination of hazardous materials. For the long-term, develop and implement a plan for a dedicated machine shop facility at a location separate from water supply facilities.

c. Improvements to protection of distribution entry point shafts 3A, 3B, and 7 are recommended to address safety concerns (ie. security lighting, perimeter fencing, improve safety access to shafts). Improved access to the shaft 7 through an entrance off Sedgewick Avenue is recommended. Further options to control outside stormwater infiltration/inflow into shafts should continue to be explored. Continue to develop and implement system-wide upgrade to telemetry monitoring system. The leaking gate valve observed in Shaft 7 should be repaired as soon as possible for water conservation purposes.

d. Continue to implement gate valve replacement activities at Shafts 17, 18, 9 and 10 to remove potential for hazardous material (mercury, PCB) contamination.

e. Continue chamber remediation activities at the Catskill Screen/Chlorination chamber to remove hazardous material (lead paint) from the walls. Improve overall housekeeping activities within the Catskill Screen/Chlorination chamber. Attention is needed in the

near future to address some minor deterioration of concrete occurring in the weir chamber.

f. Implement recommendations made to improve perimeter security (access control) at all source intakes and disinfection facilities outlined in NYCDEP's October 28, 1999 response letter. In addition to security measures, improve Operation & Maintenance (O&M) practices at all water supply facilities through review, revision, and implementation of NYCDEP's O&M plan.