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OFFICE OF THE
NEW YORK STATE COMPTROLLER

DIVISION OF STATE
GOVERNMENT ACCOUNTABILITY

NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION

DELAWARE AQUEDUCT SYSTEM: WATER LEAK DETECTION AND REPAIR PROGRAM

Report 2005-N-7

AUDIT OBJECTIVES

Our objectives were to determine whether the New York City Department of Environmental Protection (DEP) monitored the extent and nature of the leaks in the Delaware Aqueduct System; initiated repair of the leaks; and established a plan in the event of a sudden and unexpected loss of water from the System.

AUDIT RESULTS - SUMMARY

The Delaware Aqueduct System provides approximately 55 percent of New York City's water supply. DEP has known since 1988 that the component of the Delaware Aqueduct System known as the Rondout-West Branch Tunnel (RWB tunnel) has been leaking. Over the past 18 years the estimated amount of water leakage during full tunnel flow has increased from 15-20 to 30-35 million gallons of water per day.

We found that DEP did not adequately monitor the extent and nature of the leaks in the Delaware Aqueduct System in the manner that DEP's consultants recommended as necessary. In addition, while the leaks were identified years ago, DEP did not have a formal work plan to repair the leaks. Because DEP is pursuing an overall strategy to identify water sources for New York City, it has taken only limited action to address the aqueduct component with known water leaks. Also, DEP has not established an adequate plan to protect the public in the event of a sudden or imminent substantial loss of water from the Delaware Aqueduct System. As a result, we conclude that DEP has not effectively ensured the safety and welfare of New York City residents and other communities dependent on the Delaware Aqueduct System.

In 2004, an engineering consultant recommended, among other actions, that DEP perform a schedule of specific tests to monitor the tunnel. We determined that DEP has neither adhered to the consultant's recommended schedule nor carried out all specified tests. As a result, DEP does not have sufficient data to assess the current condition of the tunnel or the extent of the leaks.

We found DEP has not initiated the repair of the leaks in the RWB tunnel. In fact, DEP has yet to develop a formal work plan for the repairs. According to DEP officials, the repairs cannot be initiated until the tunnel is shut down, and the tunnel cannot be shut down until alternative sources of water can be provided to the City and other dependent communities while the repairs are being made. DEP is addressing this issue as part of a larger, comprehensive plan for the City's entire water supply and distribution system. However, DEP estimates that it will take a decade or more to finalize the plan of action and to design and build the individual projects recommended by the plan.

We believe that repairing the known leaks in the RWB tunnel at the earliest time that the tunnel can be shut down would not be inconsistent with DEP's comprehensive plan. In fact, remediation of the tunnel leaks may prove beneficial to DEP's strategy of finding and connecting alternative sources of water. We therefore recommend DEP fast track the repair of the RWB tunnel. Initially DEP reported that it would not be in a position to unwater the tunnel until 2014. However, at our closing conference, DEP officials stated that they have revised the date for unwatering the tunnel to 2011.

If conditions in the RWB tunnel deteriorate further, the water supply for millions of people could be disrupted. However, we found DEP does not have an adequate emergency response plan in place to address

the sudden failure of the tunnel. We recommend such a plan be developed.

Our report contains seven recommendations to address the testing, monitoring, and repairing of the water leaks at the RWB tunnel. DEP officials agreed with all of our recommendations. They indicated that most of them, except in one instance, are largely reflected in DEP current policy.

This report dated August 15, 2007, is available on our website at: http://www.osc.state.ny.us. Add or update your mailing list address by contacting us at: (518) 474-3271 or
Office of the State Comptroller
Division of State Government Accountability
110 State Street, 11th Floor
Albany, NY 12236

BACKGROUND

The mission of the Department of Environmental Protection (DEP) of New York City (City) is to protect the environmental health, welfare, and natural resources of the City and its residents. According to the City Charter, DEP is responsible for all City functions and operations relating to the provision of a pure, wholesome, and adequate supply of water. These responsibilities include: controlling all structures and property connected to the supply and distribution of water; planning and building all works necessary to deliver the proper and required water; and making and enforcing rules and regulations that govern and restrict the use and supply of water.

The City's water supply system serves more than 8 million residents, as well as millions living in several upstate communities. The City needs 1.2 billion gallons of water every day. It draws on a water supply that comes almost entirely from three upstate water supplies known as the Croton, Catskill, and Delaware systems. Water is delivered from reservoirs within each of these systems by gravity through a network of tunnels and aqueducts. The Delaware water supply system is made up of three primary tunnels. Our audit focused primarily on the Rondout-West Branch tunnel (RWB tunnel) where water leaks are known to exist and where DEP has devoted its testing and monitoring efforts.

Construction of the RWB tunnel started in 1937 and was completed in 1944 under the direction of the New York City Board of Water Supply, a predecessor of DEP. The tunnel was designed to have a useful life of at least 100 years. The RWB tunnel was unwatered twice for inspection: once in 1949 and a second time in 1957. It has not been completely unwatered and inspected since 1958. DEP has not conducted any leak investigations of the other two tunnels in the Delaware Aqueduct System.

DEP consists of seven Bureaus, two of which (the Bureau of Water Supply and the Bureau of Engineering Design and Construction) are actively involved in detecting leaks and planning repairs in the RWB tunnel, as follows:

- DEP's Bureau of Water Supply is responsible for managing, operating and protecting the City's upstate water supply systems to ensure the delivery of a sufficient quantity of high quality drinking water. This bureau monitors water quality, both within the City's distribution system and throughout the upstate watersheds. In addition, this bureau has responsibility for system planning, engineering, management and acquisition of lands, enforcement of watershed regulations, and security.

- DEP's Bureau of Engineering Design and Construction (BEDC) is responsible for planning, designing and constructing major water quality-related capital projects. These projects focus on two important issues for the City - the continued delivery of high quality drinking water to the City and the continued improvement of water quality within New York Harbor and estuaries.

In 1988 and 1989 a surface spring was observed in a section of the RWB tunnel, and when subsequent tests were performed in the early 1990s, DEP confirmed that water in the spring originated through leaks near two towns. In 1992, DEP estimated that during full tunnel flow, the leakage was 15 to 20 million gallons a day (MGD), or 450 to 600 million gallons a month. In 1998, concerns about the water leaks and the possible relationship to the structural integrity of the RWB tunnel prompted DEP to hire an engineering consultant firm (Consultant A) to conduct hydraulic (water leak) investigations of the tunnel. In 1999, after a risk analysis, the consultant concluded that:

- DEP has limited information/data on the leak in the RWB tunnel.
- The estimated likelihood of failure is low over the next five years and medium to high over the next 40 years. However, based on the limited data, there is a possibility the leakage rate will accelerate within the next few decades.

Consultant A proposed a two-phase action plan. During the first phase, DEP was to expedite the procurement of equipment and modify the existing equipment that would be used for rapid and effective unwatering of the RWB tunnel. In the second phase, DEP was to proceed with the design and construction necessary to unwater the tunnel safely and efficiently so that repairs can be done.

DEP has retained Consultant A as its primary consultant over the years to provide a number of services relating to the RWB tunnel as noted later in this report. The contract started out costing $5.7 million in 1998 and required the firm to provide engineering services to assist the City in investigating the condition of the Delaware Aqueduct System. The firm was also required to assist in determining the most appropriate long-term and short-term measures for restoring the hydraulic integrity of the Delaware Aqueduct System. As of June 2006, engineering consultant services related to the Delaware Aqueduct System, specifically the RWB tunnel, have cost $28.7 million.

In November 2000, a news report revealed that the RWB tunnel was leaking about a billion gallons of water every month. Soon after this report, the City Council's Environmental Committee called DEP officials to testify at a public hearing. The officials were asked how DEP intended to address the leak and to explain its implications, such as deterioration of the Delaware Aqueduct System, the purity of the water supply, etc. At this hearing, a former DEP Commissioner spoke of "the extreme remote possibility of aqueduct failure over the next five years" and offered three scenarios for addressing the tunnel leak. Noting that the Delaware Aqueduct System would have to be out of service at various times, he mentioned DEP repairs planned for 2004 and 2007, as well as the construction of a new, separate tunnel. He also described interim actions being pursued by DEP, such as future additional investigations and other efforts to learn about and to evaluate conditions in the tunnel that were causing the leak. In addition, the former DEP Commissioner said that

"there is nothing to indicate that we have an emergency situation."

Since then, DEP has gathered a large body of technical information regarding water leaks in the RWB tunnel through investigations, risk analyses, testing, and other monitoring. However, DEP has made no repairs to the RWB tunnel water leaks first discovered 18 years ago. During the audit, we met with an official of the City Council's Environmental Committee, who indicated no other public hearings or specific follow-up actions were taken by the Committee regarding the Delaware Aqueduct System subsequent to the public hearing in 2000.

AUDIT FINDINGS AND RECOMMENDATIONS

Has DEP Monitored the Extent and Nature of the Leaks in the Delaware Aqueduct System?

DEP officials do not regard the RWB tunnel leaks as a matter of immediate concern, and they attribute the long time it has taken to initiate tunnel repairs to the City's contracting procedures that DEP is required to follow and to the complex nature of the project. Recent information shows that the RWB tunnel leaks at a rate of 30 to 35 MGD when operating at full tunnel flow, which is almost twice the leak estimate of 15 to 20 MGD in 1992. Consultant A stated some water systems, perhaps this one, could leak as much as 60 MGD without failure. However, the consultant added that leakage occurring in one centralized area may be a problem. DEP officials maintain there has been no additional evidence that indicates that conditions of the tunnel have changed since the last risk assessment done by Consultant A in 2004. However, DEP has not adequately monitored the extent and nature of the leaks in the manner recommended by this consultant, and as a result, does not have as much information as it could have to assess the current condition of the RWB tunnel.

In 2004, Consultant A prepared a revised risk analysis of the RWB tunnel that states the risk of failure (structural instability such as a collapse or major puncture) within the five-year period of 2005 through 2009 is much higher than what is preferred considering the catastrophic nature of a tunnel failure. This consultant reported that the risk is 0.1 to 1 percent which is at least ten times larger than the preferred range of less than .01 percent. The revised risk analysis also indicated the tunnel was leaking at a rate of 30 to 35 MGD when it operates at full tunnel flow (900 MGD).

We found that DEP has done some monitoring of the extent and nature of the leaks in the Delaware Aqueduct System. As part of its ongoing monitoring of the City's water supply, DEP continuously monitors the flow of water and the hydraulic grade line (water level) of the RWB tunnel. In addition, DEP has established a system for monitoring the RWB tunnel, which includes photos of the springs caused by the leakage, and various water flow tests, including reservoir backflow tests, dye tests and hydrostatic tests (see Exhibit A at the end of our report for a description of these tests).

After Consultant A performed the risk analysis in 2004, the consultant prescribed a regiment of testing that, according to the consultant, was necessary to properly monitor and evaluate the integrity of the RWB tunnel. The 2004 risk analysis had specific recommendations, some of which are addressed by DEP's in-house schedule of tests while others require additional monitoring activities. BEDC officials did not follow through to ensure these tests were done. We reviewed routine monitoring reports which indicated tests performed on the

RWB tunnel for the period October 2004 through March 2006, and noted the following:

- DEP's schedule calls for monthly photographs of the surface springs caused by the leaks. We determined that DEP did not perform such tests during the six-month period January 2005 through June 2005. The schedule to take photos of the springs was changed from monthly to quarterly and finally to periodically. We found that photographs were not done for two quarterly periods from August 2005 through January 2006.

- DEP's schedule calls for reservoir backflow tests on a quarterly basis. We determined that these tests were not done for the 12-month period January 2005 through December 2005.

- Both DEP's schedule and Consultant A's schedule call for hydrostatic tests on a semi-annual basis. These tests were not performed for the 12-month period January 2005 through December 2005. DEP officials indicated that such tests could not be conducted due to environmental as well as emergency conditions.

(It should be noted that while photographs of springs, reservoir backflow tests, and hydrostatic tests were not conducted on schedule, they were done in March 2006, shortly after our audit field work ended.)

- DEP's schedule calls for dye tests on a semi-annual basis. Such tests were not done for the 18-month period October 2004 through March 2006. DEP officials stated that recent attempts to conduct additional dye tests have been unsuccessful due to equipment failure.

- Consultant A recommended regular interior inspections of the tunnel with either an autonomous underwater vehicle (AUV) or a remotely-operated vehicle, about once a year. DEP did not conduct these inspections in 2004 or 2005. DEP officials told us they expect to contract for another interior inspection by the end of 2006.

- Consultant A recommended that a revised risk analysis be done every two years. Following this schedule, the next risk analysis would occur in 2006. We were advised it would not be worthwhile to conduct a risk analysis at this time because DEP has not acquired any significant additional information regarding a change in tunnel conditions. But, as we noted, not all prescribed tests have been conducted that might yield new information for consideration.

Additionally, DEP measures water flow through the RWB tunnel by two different systems of meters located at each end of the tunnel. According to DEP's data, the water flow rates at the end of the tunnel are higher than the rates at the beginning, even though water is not added to the system between these two locations. DEP officials advised that the meters were not installed in the interest of reconciling the readings at the beginning and end of the tunnel, nor to determine the extent of the leak; instead, they are intended to monitor the variations in water flow. DEP officials compare data on these changes with hydraulic grade line readings to identify significant trends. The results of DEP's tests, combined with flow and operational data, were compiled, analyzed, and reported in a routine monitoring report by the primary consultant. These tests and the data produced go into making the engineering

judgment about the chances of a tunnel failure on which DEP officials place their reliance.

Furthermore, DEP authorized several investigations in the period between the 1999 risk analysis and the 2004 risk analysis to determine the nature and extent of the leaks from the RWB tunnel. Under its original contract, Consultant A and its subcontractors began a horizontal boring on November 23, 2002. This effort included drilling through the ground alongside of the tunnel so that technicians could inspect its condition and take rock samples. The resulting report, completed in August 2003, concluded that there were no visible changes in the ground condition.

Under another contract between DEP and Consultant B and its subcontractor, an investigation of the RWB tunnel interior was conducted on June 6, 2003. Investigators used an AUV to record images, readings and sounds throughout the RWB tunnel. This information was then compiled and evaluated by Consultant A to determine the interior condition of the RWB tunnel. The results were cited in the revised risk analysis prepared in 2004. The investigation found that the RWB tunnel was heavily cracked throughout 7,000 linear feet. The investigation identified cracks throughout the RWB tunnel, but the majority occurred in the limestone geology in two areas of the tunnel, which are adjacent to geological faults. According to the AUV inspection report, three areas of RWB tunnel segments appear to have the type of diagonal cracks typically associated with stress/displacement in the concrete liner.

The revised risk analysis prepared in 2004 recommended maintaining a flow of less than 750 MGD, to reduce the rate of cracking and leakage. BEDC and Bureau of Water Supply officials stated that they would try to implement this policy as much as operational needs permit.

We calculated from DEP data collected from November 1, 2000 through October 31, 2005 (after eliminating days showing no water flow) that the average flow of water into the RWB tunnel was 682 MGD. Previously, flow would go as high as 900 MGD, which resulted in increased pressure on the tunnel. We were advised that DEP cannot always maintain the lower flow because of problems with the Gilboa Dam and because of turbidity in the Catskill Aqueduct System.

DEP relies on these tests and investigations to determine the nature and extent of leakage from the RWB tunnel. However, Consultant A has observed that the existing data is inconclusive regarding whether leakage has increased because DEP has not conducted the prescribed monitoring tests. In the April 2006 routine monitoring report, Consultant A stated that "while the data suggests that the leakage rate (w/in the hydraulic grade line range) has increased, there remains insufficient data points with respect to time to determine whether the leakage rate is increasing (or decreasing) over time." Our reading of statements prepared by Consultant A tells us that there is uncertainty about the nature and extent of the tunnel leak, and whether or not conditions have changed since the last risk assessment in 2004.

DEP has focused on the RWB tunnel, not the Delaware Aqueduct System as a whole. DEP officials claim they see no evidence (e.g., surface expressions) of a leak in the remainder of the Delaware Aqueduct System. However, they do continuously monitor the flow of the water from the Delaware Aqueduct System and believe this monitoring would identify leaks in the other tunnels.

Recommendations

1. Adhere to the schedule of in-house and consultant-recommended monitoring tests for the RWB tunnel. BEDC should document reasons why tests cannot be done.

   (DEP officials replied to our draft audit report they have been fully following the schedule for conducting tests of the RWB tunnel except for dye testing, which cannot be done until new testing equipment is purchased.)

   Auditor's Comment: We note that dye tests were not done for an 18-month period from October 2004 to March 2006 due to faulty equipment and almost 10 months later DEP still had not acquired the equipment. We urge DEP to take steps to expedite the procurement of the equipment to perform these tests.

2. Replace faulty or inadequate testing instruments so that the consultant-recommended monitoring tests can be administered in accordance with the prescribed timetable.

   (DEP officials replied that new equipment has been specified and is an early proceed item in a contract that should be registered by July 2007.)

Has DEP Initiated Repair of the Leaks in the Delaware Aqueduct System?

We found that DEP has not initiated the repair of the known water leaks in the RWB tunnel. In fact, DEP has yet to develop a formal work plan for the repairs. According to DEP officials, the repairs cannot be initiated until the tunnel is shut down (unwatered), and the tunnel cannot be shut down until alternative sources of water can be provided to the City and dependent communities while the repairs are being made.

DEP is addressing this issue as part of a larger, comprehensive plan (Dependability Study) for the City's entire water supply and distribution system. The goal of the Dependability Study (Study), which began in 2000, is to enable inspections and repairs to be made to any of the individual critical components of the system without affecting the system-wide demand for water. DEP estimates that it will take a decade or more to finalize the plan of action and to design and build the individual projects that will be required to provide redundancy and reliability to the City's water supply and distribution system. DEP has hired consultants to determine which specific projects will be needed to reach the goal and, in 2005, DEP established a Steering Committee that has been working with the consultants.

The impetus for the Study dates back to 1992, when DEP contracted with a firm to develop a plan that would enable the City to get drinking water from the Hudson River. The contract was amended in April 2000 to include a much broader investigation of other water sources (the Study). A new five-year contract was awarded in March 2005 to complete the investigation and produce a Final Dependability Program Strategy report by 2010. This report is to explain DEP's overall strategy and describe the projects recommended for implementation.

We acknowledge the value of, and need for, the Study. However, the leaks in the RWB tunnel are also important and need to be addressed. Under DEP's current approach, decisions about the tunnel cannot be finalized until decisions about every other aspect of the water supply and distribution system have also been finalized. As a result, it could be a

decade or more before the leak repairs are completed. At the time of our audit field work, the tunnel was not scheduled to be unwatered until 2014, and no target dates had been set for the actual repairs.

Delays in repairing the leaks result in continuing water loss and the increased risk of disruptions to the water supply. We believe that repairing the known leaks in the RWB tunnel at the earliest time that the tunnel can be shut down would not be inconsistent with DEP's comprehensive plan. In fact, remediation of the RWB tunnel leaks may very well prove beneficial to DEP's strategy of finding and connecting alternative sources of water. We therefore believe DEP needs to fast track the repair of the RWB tunnel.

After we presented our audit findings to DEP officials, they informed us that providing redundancy for the RWB tunnel is a priority of the Study. They further stated that short-term repairs on the RWB tunnel would probably be able to begin in 2011, rather than 2014, as was previously expected.

We agree that 2011 is better than 2014, but we believe additional action is needed to expedite the repair efforts. As a starting point, DEP should consider defining its needs more narrowly by focusing on the RWB tunnel as a problem area and awarding less comprehensive contracts of shorter duration to allow DEP to repair the tunnel in a more timely manner. DEP should also explore the creation of an internal committee or task force to oversee and coordinate all aspects of the tunnel repair process. An outside, independent committee could then be formed to review the internal group's proposed solutions.

DEP also needs to expedite its efforts to unwater the tunnel, as the repairs cannot begin until the tunnel has been shut down. In accordance with recommendations first proposed by the primary consultant in 1999, the unwatering process was to proceed in two distinct phases. In the first phase of the process, DEP was to expedite the procurement of equipment and modify the existing equipment that would be used for rapid and effective unwatering of the RWB tunnel. In the second phase of the process, DEP was to proceed with the design and construction necessary to enable the RWB tunnel to be unwatered safely and efficiently.

However, as of March 2006, the first phase had yet to be implemented because, according to DEP officials, the problem was so complex. In fact, at the time of our audit field work, DEP had not even set target dates for the equipment procurements and modifications needed for the unwatering process. In addition, no actions had been taken on the second phase of the process.

At our closing conference, DEP officials advised us, without providing details or any documentation, that they had proceeded directly to the second phase of this project, which was expected to begin in 2007 and be completed in 2011. However, DEP had yet to acquire the equipment and complete the equipment modifications recommended by its consultant engineers in 1999 that would be needed for the unwatering process. We recommend DEP expedite these actions.

DEP has made some progress in addressing the water leaks. For example, during City fiscal year 2005-06, DEP compiled contingency work specifications that could be used by an outside contractor to unwater the tunnel for repair work in the event of a tunnel failure. DEP officials also identified eight long-term projects specifically related to the RWB tunnel. According to DEP officials, seven of the eight projects involve construction efforts that would maintain both

the supply and the quality of the City's water system, either adding storage capacity or increasing deliverability. However, as of March 2006, construction had commenced on only one project and DEP had not established completion dates for any of the eight projects.

The main reason for fast tracking tunnel repair efforts is to prevent a catastrophic tunnel failure. However, the issue of water loss is also a matter of concern. If the RWB tunnel continues to leak at a rate of 30 to 35 MGD when operating at full flow (as estimated in the 2004 risk analysis), the amount of water lost each day due to the leaks would have a value of between $66,000 and $77,000 (at the price charged by the City for metered water), or between $24 million and $28 million a year.

DEP officials believe a value should not be assigned to this lost water because water supplies are more than sufficient to meet the demands of the system's customers. They note that the New York City water system is designed with generous watersheds that allow it to collect sufficient water to withstand periods of drought. For this reason, the water lost in the leaks has no "value." However, we note that current water loss comes from within DEP's RWB tunnel, and that conditions can change. For example, if there were an extended and unusually severe drought in the region, this lost water could become very valuable. We also note that DEP actively encourages water conservation among City residents, asking them to report all water leaks and use special fixtures to promote conservation. It therefore seems appropriate for DEP to fast track tunnel repair efforts to the extent possible.

Recommendations

3. Prepare a work plan to fast track the repair of the RWB tunnel.

   (DEP officials replied to our draft audit report they have been developing, refining and implementing a work plan to repair the RWB tunnel before this audit started.)

   Auditor's Comment: Although DEP officials indicate a work plan was available, it was not provided to the auditors.

4. Explore the creation of an internal committee or task force to oversee and coordinate all aspects of addressing the leaks within the RWB tunnel. An outside, independent committee should be formed to review all aspects of the internal group's solutions to address the leak problem.

   (DEP officials replied to our draft report that they formed a committee of high-level staff from all bureaus with a role in the repairs. They plan to augment the committee with an external consultant.)

5. Define needs more narrowly by focusing on the RWB tunnel as a problem area and awarding less-comprehensive contracts of shorter duration to allow DEP to repair the RWB tunnel in a timely manner.

   (DEP officials replied they have refocused the Dependability Project to address the repairs of the RWB tunnel. They added it is not clear how to further narrow the project to speed the process.)

6. Acquire the equipment and other resources necessary for unwatering the RWB tunnel to accommodate a fast track schedule to repair the tunnel.

   (DEP replied that equipment and other resources are being acquired and work is scheduled to begin in the summer of 2007.)

Has DEP Developed a Plan in the Event of a Sudden and Unexpected Loss of Water?

Because of the risk to the public, it is incumbent upon DEP management to monitor the leaks in the RWB tunnel and to implement an emergency response plan should the leaks elevate to a critical state. We determined that DEP does not have an adequate emergency response plan in place. In the event of a sudden failure of the RWB tunnel or other component of the Delaware Aqueduct System, there is no assurance that DEP is ready to respond to such an emergency event timely.

Currently, in the event of a catastrophic or other unwanted event, the decision to declare an emergency involving the RWB tunnel would be on an ad hoc basis, and would rest with DEP's Commissioner. Aside from declaring an emergency, there is no rapid response process for high-priority construction, and just one individual is assigned to updating and compiling more than 60 emergency response and contingency plans for DEP.

The existing plan, which was last revised in November 2004, incorporates some information to help address an emergency situation in the RWB tunnel. It includes an outline of events relating to the level of the emergency, and recommends anticipated and general responses for each level. However, DEP officials have not yet defined the triggers that would initiate varying response actions. Thus, there is less assurance that their responses to a sudden emergency will be timely. According to the Bureau of Water Supply official responsible for compiling information for all of DEP's contingency plans, the information relating to catastrophic and unwanted events will be developed during 2007. The responsible official has stated that such preparation has been delayed because DEP does not have enough staff to compile the plans and because resources have been redirected to other priorities.

Recommendation

7. Revise the plan to address the failure of any component of the Delaware Aqueduct System including each of its three tunnels. This should include identifying the specific events, in order of criticality and severity that would trigger the need for varying response actions to water leaks within the Delaware Aqueduct System.

   (DEP replied that an inter-bureau working group is focused on developing a Contingency Response Plan with a consultant who is scheduled to start working for DEP in 2007. They are also gathering materials that form critical components of the final plan to speed the development process.)

AUDIT SCOPE AND METHODOLOGY

We conducted our audit in accordance with generally accepted government auditing standards. We examined DEP's water leak detection and repair program as it relates to the Delaware Aqueduct System for the period January 1, 1998 through March 31, 2006. To accomplish our objectives, we met with DEP officials and representatives of Consultant A to obtain information about the water leaks in the Delaware Aqueduct System and at the RWB tunnel within that system. In addition, we reviewed DEP's testing and monitoring activities, including steps taken to assess the nature and the amount of water leakage at the RWB tunnel. We also reviewed and analyzed pertinent laws, policies, bulletins, and procedures.

In addition to being the State Auditor, the Comptroller performs certain other

constitutionally and statutorily mandated duties as the chief fiscal officer of New York State. These include operating the State's accounting system; preparing the State's financial statements; and approving State contracts, refunds, and other payments. In addition, the Comptroller appoints members to certain boards, commissions and public authorities, some of whom have minority voting rights. These duties may be considered management functions for purposes of evaluating organizational independence under generally accepted government auditing standards. In our opinion, these functions do not affect our ability to conduct independent audits of program performance.

AUTHORITY

The audit was performed pursuant to the State Comptroller's authority as set forth in Article V, Section 1 of the State Constitution and Article III of the General Municipal Law.

REPORTING REQUIREMENTS

A draft copy of this report was provided to DEP officials for their review and comment. Their comments were considered in preparing this final audit report, and are included as Appendix A.

Within 90 days of the final release of this report, we request that the Commissioner of the New York City Department of Environmental Protection report to the State Comptroller, advising what steps were taken to implement the recommendations contained in this report, and where recommendations were not implemented, the reasons why.

CONTRIBUTORS TO THE REPORT

Major contributors to this report include Carmen Maldonado, Gerald Tysiak, Santo Rendon, Jeny Varghese, Matthew Phillips, and Paul Bachman.

Reservoir Backflow Tests - These tests estimate the RWB tunnel's leakage rate by stopping inflow at the Roundout Effluent Chamber at the upstream end of the tunnel, and opening the tunnel to the West Branch Reservoir, at the upstream end. This rate is based on the velocity of the flow from the West Branch Reservoir into the RWB tunnel.

Dye Tests - Dye is injected into the tunnel, and the time it takes to travel through the system is measured. This is the only test that can be conducted at a full tunnel flow to calculate the leakage rate.

Hydrostatic Tests - These tests are conducted by stopping a flow through a section of the tunnel and then measuring the drop in water elevation.

APPENDIX A - AUDITEE RESPONSE

DEPARTMENT OF ENVIRONMENTAL PROTECTION
59-17 Junction Boulevard
Flushing, New York 11373

Emily Lloyd
Commissioner

April 6, 2007

Carmen Maldonado, Audit Director
Office of the State Comptroller
Division of State Services
State Audit Bureau
123 William Street – 21st Floor
New York, New York 10038

Re: Audit 2005-N-7

Dear Ms. Maldonado:

I am writing in response to your letter of February 28, 2007, transmitting the final draft report issued pursuant to the Office of the State Comptroller's (OSC's) audit of *The New York City Department of Environmental Protection's (DEP's) Delaware Aqueduct System: Water Leak Detection and Repair Program.* Your letter requested that DEP provide a written response to the draft report.

First, I would like to acknowledge the work of the OSC audit staff dedicated to this effort. As you have no doubt learned, New York City's water supply system is a vast and complex network. And while we are in agreement with many of the constructive recommendations found within the draft report, and had begun implementing many of them even in advance of the audit, we feel that the overall tenor of the report does not demonstrate an understanding of some of the most central facts, and therefore does not accurately portray the progress that has been made toward funding and implementing a solution to this very complex problem.

Listed below are the assertions that should be corrected before the audit report is issued in final form. Before addressing these specific points, I would like to bring to your attention several key facts concerning the repair:

1) We are about to award a contract for $239 million for the first piece of the repair: the rehabilitation of Shaft 6, an access point to the tunnel, located in Dutchess County.

2) The planning for the repair of the Rondout West Branch Tunnel (RWBT) portion of the Delaware Aqueduct is a priority focus of a larger study aimed at diversifying New York City's water supply. The work of the study is a crucial part of the repair process because we will need to close a piece of the aqueduct for a time in order to repair it. In the context of global climate change, it is both critical and prudent that our approach be cost effective in the long, as well as the short term. Cities around the world are taking a similar look at their water supply systems, and working to identify and develop additional water sources. We are learning from other research, as well as our own, as we carry out our planning.

www.nyc.gov/dep
Dial 311 Government Information and Services for NYC

Following below are the specific assertions and their corresponding corrections:

The Delaware Aqueduct leaks do not translate into lost revenue:

The OSC attempt to assign a cost to the Delaware Aqueduct leaks shows a fundamental misunderstanding of water as a commodity in New York City. Counting the lost water as lost revenue would be valid only if the City was unable to meet customer demand. New Yorkers are only charged for, and they only pay for, the water they use. Unlike many parts of the world, New York City's water supply is self-replenishing and, under all but extreme circumstances, exceeds demand. As is the case with most reservoir based water supply systems throughout the world, the New York City system is designed with generous watersheds that allow it to collect sufficient water to withstand periods of drought. Consequently during average and wetter-than-average periods it is normal for excess reservoir water to be spilled back into nearby rivers and streams. For instance, over the past 2 years, as part of the normal operation of our water supply system, DEP spilled an average of more than 1.9 billion gallons per day from its reservoirs, 626 million gallons per day of that from the Delaware alone. Clearly both of these numbers far exceed the 13 million gallons per day lost on average through the leaks.

Tests and monitoring have established that the tunnel structure and the leakage rate are stable:

DEP is consistently and frequently monitoring the leak and making steady progress on the repair program. DEP has continuously monitored, studied and tested the leak and the effects of the leak, including conducting 56 dye tests, 14 backflow tests, 13 hydrostatic tests, hourly flow monitoring, and weekly hydraulic grade line measurements. We have followed a prudent and thorough testing regimen, modifying it with our knowledge of changing conditions and operating realities.

Making the actual repair is a major undertaking which involves shutting down and temporarily replacing the capacity of the Aqueduct, which currently provides 50 percent of the City's water. Before we can begin the repair, we have to put in place supplementary supply from alternative sources. An amount of water equivalent to the shortfall that a shutdown of the Delaware Aqueduct would create will be provided through a combination of conservation, new construction, renovation and/or increased usage of existing facilities and supply.

As stated above, the contract for the first part of the repair will be awarded this spring and work will begin this summer.

DEP is upgrading its emergency plan:

Although the leak is stable, DEP is expanding and enhancing the emergency plan to better address emergency coordination, communications, and options for emergency repair. The new emergency plan will include standard operating procedures for determining a change in status of the tunnel, pre-written contracts, organizational structure, and updated contacts for all local emergency management personnel. DEP has established an in house working group, which will be augmented with assistance from an external consultant with expertise in preparing,

testing and exercising emergency response plans. DEP has retained Ecology & Environment, Inc. to compile and complete the work already begun in-house.

We have attached a detailed response to the 7 recommendations for DEP's consideration. We have found most of the recommendations to be sensible and, except in one instance, largely reflected in current DEP policy.

Again, we appreciate the hard work and attention of your staff.

Sincerely,

for

Emily Lloyd

AUDIT ASSERTION	DEP RESPONSE
"Over the past 18 years the estimated amount of water leakage during full tunnel flow has increased from 15-20 to 30-35 million gallons of water per day."	**DEP has limited confidence in the 1992 estimate of the rate of tunnel leakage. Therefore there is little basis to believe that the rate of tunnel leakage has changed. The estimate made in 1992 was based on extremely limited data and did not take into consideration the fact that the rate of leakage would not increase in a linear fashion as the tunnel flow increased but rather that the rate of leakage increases significantly at higher flow regimes. For this reason, DEP has lowered the average flow in the tunnel to reduce any undue stress.**
"On August 16, 2006, at the closing conference to our audit, DEP officials advised that they have changed their approach to the leaks in the RWB tunnel and are now focusing on this issue which has resulted in moving up the expected date of commencing repairs to 2011."	**In this location and elsewhere the draft report appears to indicate that DEP plans to unwater the tunnel and commence planned repairs in 2011. The 2011 date is the point at which DEP will be able to withstand a longer tunnel outage and more comfortably perform a short term emergency repair to the tunnel. This is because the Croton Filtration Plant, Cross River pumping station and Croton Falls pumping station projects are anticipated to be complete by that time.** **These projects, which will prepare DEP to more comfortably perform a short term emergency repair, are either under construction or will begin soon. The Croton Filter Plant project is already underway. The Shaft 6 rehabilitation and dewatering contract, which will permit access to the Aqueduct, will be awarded in this quarter for $239 million. The Cross River pumping station project is scheduled to start in the fall of 2007, cost $13 million and take two years to complete. The Croton Falls pumping station project is scheduled to begin in the fall of 2008, cost $42 million and also take two years to complete.**
"Every day, the RWB tunnel is leaking at a rate of 30 to 35 MGD when operating at full tunnel flow. As of July 1, 2005, the retail cost of metered water in the City was $1.65 for 100 cubic feet of water, which is the equivalent of 748 gallons. Based on the 2004 risk analysis, the consultant reported the tunnel was leaking at a rate of 30 to 35 MGD when it operates at full tunnel flow capacity (900 MGD). At this rate, the RWB is potentially leaking water valued between $66,000 and $77,000 on a given day, or between $24 million and $28 million per year."	**The underlying assumption here is that the water leaking from the tunnel would have otherwise gone to consumers if it had not been part of the leak. If this water had not leaked from the tunnel it would have been released or spilled from the storage reservoirs from which it flowed and no revenue would have been collected. In fact, over the last two years, the volume of water spilled has been 20 to 40 times the volume of water leaking from the Aqueduct.**

RECOMMENDATIONS

1)	"Adhere to the schedule of in-house and consultant-recommended monitoring tests for the RWB tunnel. BEDC should document reasons why tests cannot be done."	**Agree - The Department has been fully following its schedule for conducting testing of the RWB tunnel except for dye testing which has not been conducted due to the need to acquire new, reliable testing equipment to conduct this particular type of evaluation and (2) Hydrostatic/Backflow tests during the severe Catskill System turbidity of 2005 as discussed during the Audit process. However, since then the Department has been on schedule with Hydrostatic and Backflow Tests.**
2)	"Replace faulty or inadequate testing instruments so that the consultant-recommended monitoring tests can be administered in accordance with the prescribed timetable."	**Agree – The existing equipment has not proven to be adequate for the task. New equipment has been specified and is an "early proceed item" on contract DEL-283 which is expected to be registered in July 2007.**
3)	"Prepare a work plan to fast track the repair of the RWB tunnel."	**Agree – DEP has been developing, refining and implementing a work plan to repair the RWB tunnel since before the start of this audit. In short, the plan is to develop the alternative supply needed to allow for a planned shut-down of the tunnel while continuing the investigation of the leak, utilizing information from the investigation to design a permanent repair which will be executed once the necessary additional water supply is available.**
4)	"Explore the creation of an internal committee or task force to oversee and coordinate all aspects of addressing the leaks within the RWB tunnel. An outside, independent committee should be formed to review all aspects of the internal group's solutions to the leak problem."	**Agree – The Department has formed an internal committee that includes high level staff from all bureaus that have a role in the repair of the RWB tunnel leak or the provision of an adequate supply in the event of a planned or unplanned tunnel outage. This working group will shortly be augmented with assistance from an external consultant with expertise in preparing, testing and exercising emergency response plans.**
5)	"Define needs more narrowly by focusing on the RWB tunnel as a problem area and awarding less-comprehensive contracts of shorter duration to allow DEP to repair the RWB in a timely manner."	**Agree – The long term alternate water supply is being addressed under the ongoing, refocused Dependability Project. The planning for the repair of the RWBT is a priority focus of this larger study aimed at diversifying New York City's water supply. DEP's focus on the repair of the RWBT is sufficiently narrow. It is unclear how DEP would further narrow that focus to speed the process of executing a tunnel repair given the fact that the limiting factors are the unwatering capacity at Shaft 6 and ensuring an adequate supply. The Shaft 6 work is being addressed under the $239 million DEL-185 contract (contractor has been selected and work is to begin in summer 2007).**
6)	"Acquire the equipment and other resources necessary for unwatering the RWB tunnel to accommodate a fast track schedule to repair the tunnel."	**Agree – Such equipment and other resources are being acquired under DEL-185 for which a contractor has been selected. Work under this contract is scheduled to begin in the summer of 2007.**

7)	"Revise the plan to address the failure of any component of the Delaware Aqueduct System including each of its three tunnels. This should include identifying the specific events, in order of criticality and severity that would trigger the need for varying response actions to water leaks within Delaware Aqueduct System."	**Agree - The inter-bureau working group described above (at Recommendation 4) is focused on developing a comprehensive Contingency Response Plan with the assistance of the outside, emergency planning consultant scheduled to start working for the Department in April 2007. In the interim, the working group is gathering and developing materials that will form critical components of the final Contingency Response Plan to speed the development process.**