

# New York City's Delaware Aqueduct: Wawarsing Leak Investigation

by Ira A. Stern

The Delaware Aqueduct is the world's longest water tunnel, extending from New York State's Catskill Mountains to New York City – a distance of 85 miles. It delivers water from four large reservoirs of the City's Delaware System – the Rondout, Neversink, Pepacton and Cannonsville. It has delivered high quality water to nine million people in New York City and certain upstate communities on a continuous basis since its completion in 1944. The 44.2 mile section of the aqueduct known as the Rondout-West Branch Tunnel (RWBT) is the subject of this article.

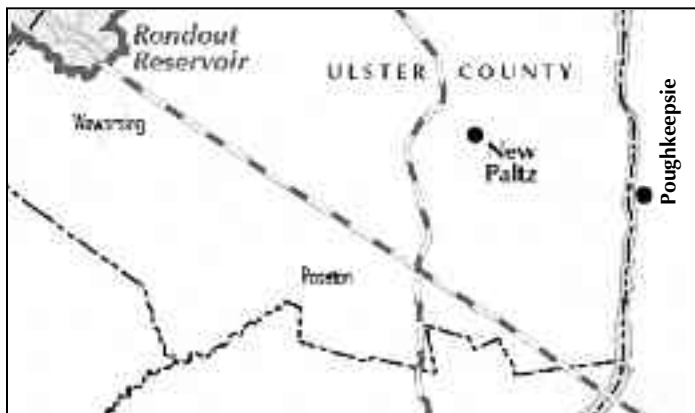


Image courtesy of NYC/DEP

This map shows the extensions of both the Delaware and Catskill aqueduct tunnels.

This deep bedrock, concrete lined tunnel is pressurized, up to 517 psi (pressure per square inch), and is circular in shape with a diameter of 13 feet, six inches. It carries an average of 50 percent of the City's annual water supply (capacity of approximately 900 million gallons per day) and is one of the most critical pieces of infrastructure operated and maintained by the New York City Department of Environmental Protection (DEP), which is responsible for the operation and maintenance of the City's water supply system.

Based on an ongoing monitoring process, it is estimated that the leakage rate in the RWBT is between 14 and 36 mgd daily. The DEP has and continues to conduct extensive investigations and studies regarding the nature and extent of these leaks. An Autonomous Underwater Vehicle (AUV) has filmed and generated hundreds of thousands of data points. Hydrostatic and backflow tests have documented leakage rates as have weekly shaft and tunnel elevation readings. The City also maintains a real time Supervisory Control and Data Acquisition (SCADA) network that monitors tunnel pressure and flow.

The City has also initiated an extensive capital repair and replacement project for the RWBT, which includes replacement of

certain valves and dewatering equipment, studies of alternatives for replacement and repair of the tunnel, and research and testing of in-situ rehabilitation options of the tunnel lining itself. While this effort is progressing rapidly, an undertaking of this size and complexity could take several years to resolve.

The key results of the investigations to date reveal that the tunnel leakage has remained constant over time. The AUV has shown that the leakage occurs through a series of "spider cracks" in the concrete lining that is predominantly located in two geographic sections of the tunnel. Not coincidental is that these two sections – Wawarsing, NY and Roseton, NY – were the most difficult to build because of high groundwater and limestone geology. These conditions required the construction of steel lined sections of tunnel to prevent groundwater infiltration. Farthest from New York City and greatest in delay to tunneling is the water bearing rock structure under the Rondout Valley at Wawarsing.<sup>1</sup> There is also documented surface and sub-surface evidence of leaking tunnel water in these areas.

On March 26, 2008 a regional newspaper ran the headline – "Leaking Aqueduct Swamping Homes: NYC Water Tunnel Runs Under Part of Wawarsing."<sup>2</sup> The article included accounts of local homeowners complaining of flooded basements and yards and alleging that the City's tunnel was the culprit. This was the first DEP had heard of this concern since similar claims were made in the early 1990s. At that time, dye testing had confirmed surface expression of tunnel water in certain nearby springs, but not in or around the homes referred to in the article. (The tunnel lies approximately 600 feet below the surface in this location.)

The DEP immediately contacted the Town in order to begin a monitoring effort in the neighborhood. Working with a few of the homeowners, a list was developed of people who were experiencing flooding and inundation problems. While DEP was aware that there



Photo courtesy of NYC/DEP

Conditions required the construction of steel lined sections of the Rondout-West Branch Tunnel to prevent groundwater infiltration.

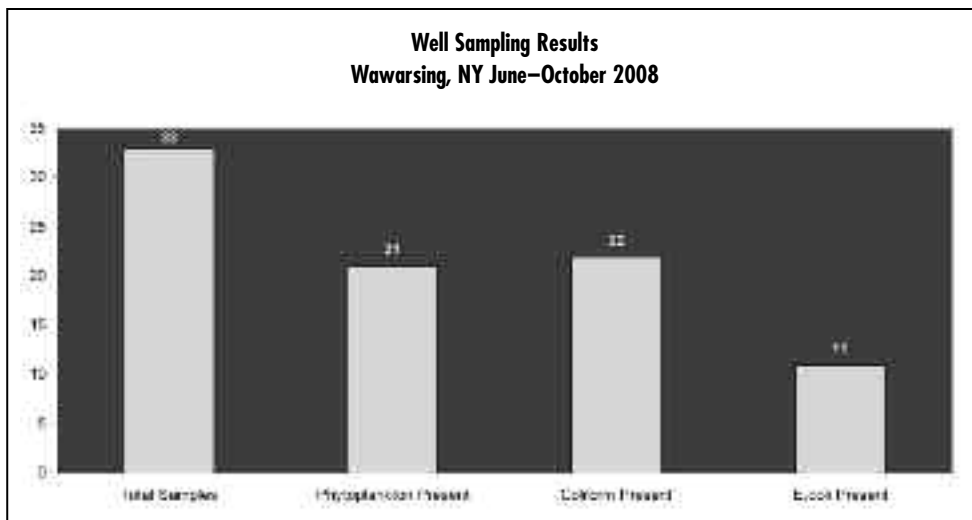
was a high groundwater condition present during the construction of the tunnel in the area, water samples were taken from each home a week later with the goal of beginning to develop a baseline and to see if there were any indicators of surface (or reservoir) water that would not normally be found in groundwater. This survey was a good way to meet many of the homeowners and to get a better feel for the forces at play with regard to the flooding. While initial sample results were inconclusive, the survey did confirm the area as having shallow groundwater and poor surface water drainage. Microbiological analyses for phytoplankton did not show an initial presence of algae typically found in surface water. Chemistry sample results indicated

two groups of data: the first group shared some similarities with reservoir water chemistry; the second group had chemistry results much higher than specific conductance and total alkalinity values typical of the Rondout Reservoir. The variety of results pointed to the need for a more formal long-term study of the area.

At the same time, public and political concern grew and DEP began to attend town board and special public meetings regarding community concerns. There were many questions pertaining to the tunnel location and condition; plans to repair and replace the aqueduct; demands for DEP to buy homes, drill wells, pay electric bills, provide sump pumps, and build stormwater infrastructure. There were also concerns that if the tunnel water was artificially raising the water table in the area, cross-contamination between septic systems and wells could be occurring. The Ulster County Health Department conducted a sanitary survey of wells in the area to determine if any public health risks existed. Not surprisingly, this area of shallow wells and proximate septic systems showed the presence of coliform and *e. coli* bacteria in many of the samples.

The DEP promptly directed its consultant on the Rondout–West Branch Tunnel rehabilitation, Malcolm Pirnie, Inc., to intensify efforts to monitor tunnel leakage in Wawarsing. The DEP also commissioned an independent study by the United States Geological Survey (USGS), to investigate the geologic conditions in the area with a particular emphasis on determining the role of the leaking tunnel water into the groundwater aquifer, if any. It is necessary to understand on a scientific basis where the water from the tunnel is going and what effect, if any, it has on well elevations, basement inundation, and stormwater flow in the neighborhood.

The USGS will study the hydro-geologic framework of the valley sediments and bedrock. The establishment of a complete groundwater level network will be used to measure aquifer elevation and changes over time. The USGS has already started the study using existing wells of some of the homeowners and the Town. It has plans to drill new test wells at various elevations and locations, and to use radar technology to trace water origin. In addition, seismic readings will be taken to provide documentation of bedrock patterns, including cracks and fissures. By measuring groundwater level changes, determining fracture patterns in bedrock, observing precipitation and tunnel operations, and age-dating ground and surface water, it is anticipated that the study will be able to identify the sources of high water tables and seepages in the future.



The Ulster County Health Department’s sanitary survey of wells in the tunnel area

Image courtesy of NYC/DEP

### Advisory Committee Formed

It became apparent that an ongoing forum would be needed to address all of these concerns and to make sense of the scientific studies as they unfolded over time. By the end of June 2008, the DEP created a Project Advisory Committee (PAC) comprised of homeowners, the Town of Wawarsing, the County Health Department, NYS Department of Transportation, and the local Congress and State representative’s offices. The PAC’s goal is “to address issues and concerns regarding the Delaware Aqueduct leak and other water problems in the Wawarsing area.” This outreach committee’s activities include reviewing scopes of work for upcoming studies and providing study updates, sharing results of water testing, considering and developing programs to aid the homeowners with certain problems they were having that could be potentially tied to the tunnel leak, and to provide regular communication on rehabilitation efforts regarding the tunnel and other related issues.

The DEP decided that until such time as the USGS study was completed, it would provide, as a gesture of good faith to the community, a certain level of financial resources to the Town to address the homeowners most critical concerns. This support was provided through the Town of Wawarsing in exchange for its assistance in the conduct of the investigation. Even though the sample results collected by the City and County could be attributable to a variety of sources and conditions in the area, it was decided that protecting drinking water, assisting with basement pumping, and providing cost-sharing for local stormwater projects would bring some measure of short-term relief to the concerned neighborhood. While this did not meet all the demands and concerns of the homeowners, supporting these areas would enable the studies to move forward and provide some support to the homeowners. Once the USGS study was completed, the DEP promised to reconsider its level of support in relation to the findings.

In this situation, the DEP has decided on a comprehensive approach that combines scientific study, regular communication with the public, and a certain level of financial support for essential projects in the concerned area. The RWBT, the longest water tunnel in the world, is leaking 14 to 36 mgd, and the DEP is actively pursuing several alternatives to fix the leak and continues to monitor it to ensure the safety of the water supply for New York City.

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The use of a PAC has enabled the agency to communicate more effectively with the local residents and to develop an ongoing relationship with them. This strategy will improve access to critical data needed to ascertain the groundwater and geologic issues in the area and to help expose the residents to watershed and groundwater science. The PAC has also improved the dialogue between the various government agencies that operate in this area, which will be critical as the study findings point to new initiatives – whether or not it is determined that the tunnel is a cause of the area’s many water problems.

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**Citations**

1. The Delaware Water Supply News, February, 1941
2. Times Herald Record, March 26, 2008



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