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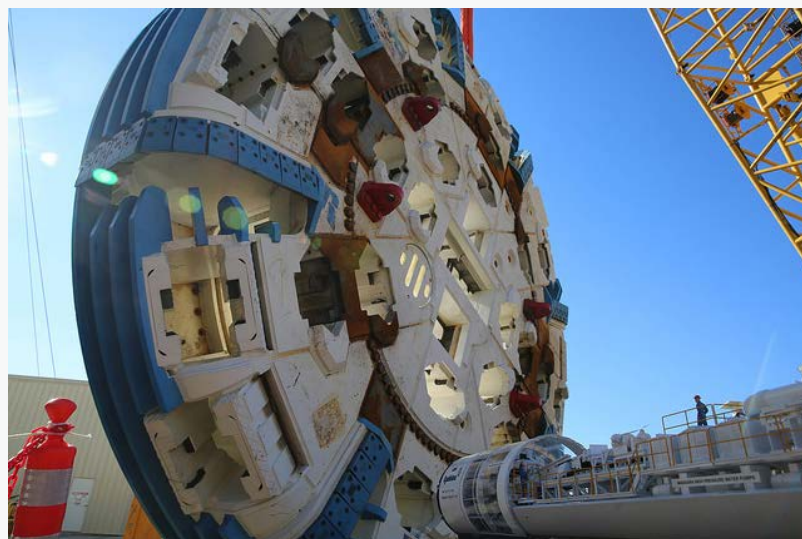
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NYC DEP Announces the Start of Tunneling for \$1 Billion Project to Repair the Delaware Aqueduct



Project comprises the largest repair in the 175-year history of NYC water supply system

DEP dedicates tunnel boring machine “Nora” in honor of groundbreaking engineer, suffragist

High-resolution photos of the project and today’s event can be found on [DEP’s Flickr page](#)

The New York City Department of Environmental Protection (DEP) today was joined by federal, state and local representatives, honored guests, and dozens of construction workers to mark the start of tunneling for the Delaware Aqueduct Bypass Tunnel—the largest repair project in the 175-year history of New York City’s drinking water supply. The \$1 billion project will repair two areas of leakage within the 85-mile Delaware Aqueduct, the longest tunnel in the world. The primary leak will be eliminated through the construction of a 2.5-mile bypass tunnel, which will be drilled 600 feet below the Hudson River from Newburgh to Wappinger.

The tunnel will be driven by one of the world’s most advanced tunnel boring machines. The machine—which measures more than 470 feet long and weights upwards of 2.7 million pounds—was also dedicated today in honor of Nora Stanton Blatch Deforest Barney, a noted suffragist and the first woman in the United States to earn a college degree in civil engineering. Nora, who worked as a draftsman on the City’s first reservoir and aqueduct in the Catskill Mountains, was also the first female member of the American Society of Civil Engineers.

“The start of tunneling to repair the Delaware Aqueduct is a major milestone in the

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history of New York City's water supply system," **DEP Acting Commissioner Vincent Sapienza** said. "While the City has added new facilities to its water supply over the past century, repairs approaching this magnitude have been few and far between. The effort to fix the Delaware Aqueduct is by far the most complex DEP has undertaken, and it highlights the absolute need to keep our public works in a state of good repair."

The next phase of construction for the bypass tunnel will begin next week when construction workers in Newburgh begin to lower the \$30 million tunnel boring machine (TBM) into a subsurface chamber that is located 845 feet below the ground. The machine is currently being stored in 22 pieces. It will take workers approximately 4 months to assemble the TBM.

The TBM is an integral part of DEP's program to fix two leaks in the Delaware Aqueduct. The largest of the two leaks is located along the western bank of the Hudson River in Newburgh. The TBM will be used to build a 14-foot diameter bypass tunnel alongside this section of the aqueduct. The 2.5-mile bypass will be constructed 600 feet below the Hudson River, from Newburgh to Wappinger. Once finished, it will be connected to structurally sound portions of the existing Delaware Aqueduct to convey water around the leaking section. The leaking stretch will be plugged and permanently taken out of service.

The new tunnel will be driven by the TBM and more than 100 workers at the site. The TBM is a massive and unique piece of equipment. The entire machine—including its cutter head, body and trailing gear—is more than 470 feet long and weighs upwards of 2.7 million pounds. Its cutter head is 21.6 feet in diameter. The TBM was built to withstand 30 bar of pressure—believed to be the most of any TBM ever manufactured. (That's about 11 times the amount of pressure from a garden hose.) The machine needs to withstand that much pressure because workers encountered huge inflows of water under immense head pressure when the aqueduct was first built more than 70 years ago. The TBM is also equipped with dewatering equipment to pump 2,500 gallons per minute away from the tunnel as the machine pushes forward. In addition, the machine is outfitted with equipment to install and grout the concrete lining of the tunnel, and to convey pulverized rock to a system of railroad cars that will follow the TBM as it works. The railroad cars will regularly travel back and forth between the TBM and the bottom of Shaft 5B in Newburgh, delivering workers, equipment and rock between the two locations. Once the TBM begins its work, DEP expects it will drive about 50 feet of tunnel per day. Work on the tunnel will continue 24 hours a day, five days a week. Tunneling is expected to take 20 months.

Over the past several months, workers have already blasted 130 linear feet of "starter tunnel" in the direction that the TBM will work. The starter tunnel makes room for the TBM to work and gets it pointed in the right direction—akin to tapping a nail into wood before you begin hammering.

The finished bypass tunnel will be reinforced by 9,200 linear feet of steel and a second layer of concrete after the TBM is finished driving its path beneath the river. Once those are in place, DEP will shut down the Delaware Aqueduct to connect the bypass tunnel to the existing aqueduct. The approximately 6-month shutdown is planned for October 2022. The project is expected to be finished in 2023.

TBM Named in Honor of Nora

DEP was also joined today by descendants of Nora Stanton Blatch DeForest Barney, the groundbreaking engineer for whom the TBM was named. DEP announced in March that it would name the machine after Nora, who became the first woman in the United States to earn an engineering degree when she graduated from Cornell University in 1905. That year, she also became the first woman to gain membership in the American Society of Civil Engineers, as a junior member. After she graduated from Cornell, Nora worked as an engineer and draftsman for the American Bridge Company, Radley Steel Construction Company, and the New York Public Service Commission. Later in life she became a developer and architect on Long Island and in Greenwich, Connecticut.

“It is an honor for our grandmother, Nora, to lend her name to this unique tunnel boring machine,” said **Coline Jenkins, the granddaughter of Nora**. “Both Nora and NORA are ground breakers, here to overcome obstacles and create a stronger society for millions of citizens.”

From 1906–1908, Nora worked as a draftsman for the New York City Board of Water Supply as it developed the first parts of the Catskill Water Supply System. She was paid \$1,200 per year for her work—the highest salary of any draftsman on the project. All the others fulfilling that job were men. Little exact information is known about Nora’s work on water supply infrastructure in the Catskills. But a 1908 story from The New York Times said she had “done much difficult work on dams and weirs” for the project—an explanation that would suggest she drafted some of the infrastructure for Ashokan Reservoir and the headworks of the Catskill Aqueduct.

Nora was also noted for her work in the women’s rights movement. Her involvement was something of an heirloom passed down by her grandmother and mother. Her grandmother, Elizabeth Cady Stanton, authored the “Declaration of Sentiments” that was presented at the Seneca Falls Convention of 1848, marking the start of an organized push for women’s rights and women’s suffrage in the United States. Nora’s mother, Harriot Stanton Blatch, was also a noted suffragist who injected new energy by broadening the movement to include working-class women in New York City, and by organizing parades up Fifth Avenue, protests at Carnegie Hall, and lobbying efforts at the State Capitol in Albany. Nora continued in that tradition. She founded a suffrage club at Cornell, became president of the Women’s Political Union in 1915, and led the charge for an Equal Rights Amendment to the U.S. Constitution that would have guaranteed women equal rights in the workplace. The amendment was not ratified, but it has been debated in Congress almost every year since it was introduced, including as recently as 2015.

Nora Stanton Blatch DeForest Barney died in 1971 at the age of 87.

Repairing and Monitoring Leaks in the Delaware Aqueduct

DEP has monitored the two portions of the aqueduct with leaks—one in the Orange County town of Newburgh, and the other in the Ulster County town of Wawarsing—since the 1990s. The leaks release an estimated 20 million gallons per day, about 95 percent of that escaping the tunnel through the leak in Newburgh. DEP has continuously tested and monitored the leaks by using dye, backflow, and hydrostatic tests, and hourly flow monitors provide near real-time data on the location and volume of the leaks. In 2003, 2009 and 2014, DEP used an Autonomous Underwater Vehicle (AUV)—a cutting-edge, self-propelled submarine-shaped vehicle built in partnership with engineers at Woods Hole Oceanographic Institution in Massachusetts—to conduct a detailed survey of the entire 45-mile length of tunnel between Rondout Reservoir and West Branch Reservoir. The AUV took 360-degree photographs while gathering sonar, velocity, and pressure data to assist in determining the location, size and characteristics of the leaks. All the data gathered thus far clearly show that the rate of water leaking from the tunnel has remained constant and the cracks have not worsened since DEP began monitoring them in 1992.

In 2010, the City announced a plan to address the leaks by building the bypass tunnel around the portion of the aqueduct in Newburgh, and also grouting closed the smaller leaks in Wawarsing. The project began with the excavation of two vertical shafts in Newburgh and Wappinger to gain access to the subsurface. These shafts, 845 and 675 feet deep respectively, were completed last year. Workers recently completed an underground chamber at the bottom of the Newburgh shaft. The chamber—about 40 feet high, 40 feet wide and 100 feet long—will serve as a staging area for the tunnel boring machine and the spot from which excavated rock is brought to the surface by a large crane.

The existing Delaware Aqueduct will stay in service while the bypass tunnel is under construction. Once the bypass tunnel is nearly complete and water supply

augmentation and conservation measures are in place, the existing tunnel will be taken out of service and excavation will begin to connect the bypass tunnel to structurally sound portions of the existing aqueduct. While the Delaware Aqueduct is shut down, work crews will also enter the aqueduct in Wawarsing to seal the small leaks there, roughly 35 miles northwest of the bypass tunnel.

The project will mark the first time that the Delaware Aqueduct will be drained since 1958. In 2013, DEP installed new pumps inside a shaft at the lowest point of the Delaware Aqueduct to dewater the existing tunnel before it is connected to the new bypass tunnel. Those pumps will be tested several times before the tunnel is drained in 2022. The nine pumps are capable of removing a maximum of 80 million gallons of water a day from the tunnel—more than quadruple the capacity of the pumps they replaced from the 1940s. The largest of the pumps are three vertical turbine pumps that each measure 23 feet tall and weigh 9 tons.

The bypass tunnel project is expected to create nearly 200 jobs over the next eight years. In 2012, DEP signed a project labor agreement (PLA) with the Hudson Valley Building and Construction Trade Council that ensured the vast majority of those jobs would be filled by local workers. Also, the PLA is expected to save the City up to \$23 million over the life of the project. With 18 different local labor agreements that could potentially apply to the project, the PLA provides for a unified approach to shifts and time off, and the increased coordination under one agreement allows for more cost-effective scheduling and increased flexibility.

DEP manages New York City's water supply, providing more than 1 billion gallons of high-quality water each day to more than 9.5 million New Yorkers. This includes more than 70 upstate communities and institutions in Ulster, Orange, Putnam and Westchester counties who consume an average of 110 million total gallons of drinking water daily from New York City's water supply system. This water comes from the Catskill, Delaware, and Croton watersheds that extend more than 125 miles from the City, and the system comprises 19 reservoirs, three controlled lakes, and numerous tunnels and aqueducts. DEP has nearly 6,000 employees, including almost 1,000 scientists, engineers, surveyors, watershed maintainers and other professionals in the watershed. In addition to its \$70 million payroll and \$166 million in annual taxes paid in upstate counties, DEP has invested more than \$1.7 billion in watershed protection programs—including partnership organizations such as the Catskill Watershed Corporation and the Watershed Agricultural Council—that support sustainable farming practices, environmentally sensitive economic development, and local economic opportunity. In addition, DEP has a robust capital program with \$20.7 billion in investments planned over the next 10 years that will create up to 3,000 construction-related jobs per year. For more information, visit nyc.gov/dep, like us on Facebook at facebook.com/nycwater, or follow us on Twitter at twitter.com/nycwater.

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