In 2003, the latest round of innovation is installed at the Little Falls plant. The 1986 filter building can be seen standing upon the foundation laid by George W. Fuller a century before. *Photo courtesy of the Passaic Valley Water Commission.*

DAVID M. PRANITIS

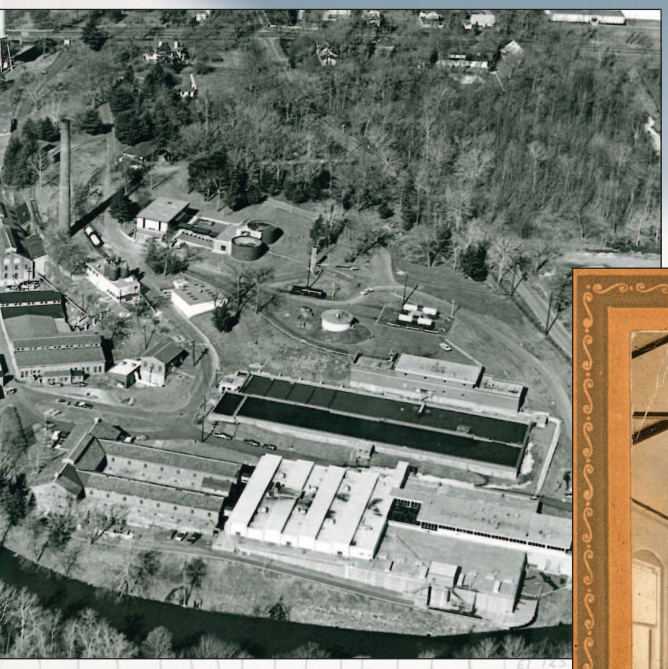
Little Falls Water Treatment Plant: Where History and Innovation Meet

THE LITTLE FALLS WATER TREATMENT PLANT HAS ROOTS IN POSTCOLONIAL HISTORY, HAVING SPRUNG UP IN TOTOWA, N.J., ON THE CUTTING EDGE OF AMERICAN INDUSTRY IN THE LATE 1800S. MAINTAINING ITS TRADITION OVER THE YEARS, THE PLANT HAS CONTINUED TO IMPROVE USING MODERN SCIENCE AND ENGINEERING TO THE BENEFIT OF ITS MORE THAN 500,000 CUSTOMERS.

They will tell you in Totowa, N.J., that the Little Falls Water Treatment Plant stands at the intersection of Union Boulevard and Riverview Drive. You will be given that address, of course, unless you happen to be listening to a student of the rich history of drinking water treatment technology and learning of the role that northern New Jersey has played in advancing that technology. A guide of that sort will tell you that the Little Falls plant stands at the remarkable intersection of history and innovation.

WATER FOR A BURGEONING METROPOLIS

In postcolonial American development, Paterson, N.J., which is situated across the Passaic River from present-day Totowa, deserves special mention as one of the nation's first planned industrial cities. The city's founders, including Alexander Hamilton, put down roots in 1791 with the intention of competing with the industrial powers of Europe. In the following decades, the city's leaders actively fostered the development of diverse manufacturing of cotton, silk, linen, and iron, as well as associated industries such as machine works. By the mid-1800s, Paterson's population and industrial activity had outstripped the capacity of its antiquated system of wells to provide suitable drinking water. Continued growth demanded that the waters of the Passaic River, on the banks



Above: The Little Falls Water Treatment Plant (Totowa, N.J.), c. 1978, including the original East Jersey Water Co. pumping station and boiler house from 1898 (center left) and George W. Fuller's filter works (lower left). Right: Workers John DeStooge and John Hook stand in George W. Fuller's filter building (1909). *Photos courtesy of the Passaic Valley Water Commission.*

of which Paterson was built, be accessed for the public drinking water supply.

In 1854, the newly created Passaic Water Co. began operations at Paterson's Great Falls, pumping river water to a reservoir that gravity-fed water mains throughout the city and environs. Not surprisingly, by the 1880s, river water taken from the heart of the burgeoning industrial center was found to be less than satisfactory for human consumption.

In 1897, the recently formed East Jersey Water Co. established a new Passaic River intake 5 mi upstream (see the left-hand photograph on this page) and built a pump station there to move that water to a new reservoir at Great Notch, 200 ft higher than Great Falls. The new pump station thus fed Paterson and the surrounding communities of more than 250,000 people with 20 mgd of untreated Passaic River water. Jersey City was also supplied with about 30 mgd.

Interestingly, there is no Little Falls. Before the 20th century, there was a small waterfall in the Passaic River at about the location of its intersection with the old Morris Canal. The rocks that made up these falls were blasted and largely depleted as ready building materials, and the falls themselves ceased to exist by the time the Little Falls pumping station was built. The 1898 pump station and boiler house were constructed of stone taken from the quarry near where these structures now stand. Technically termed "Triassic sandstone," and more colloquially known as "brownstone," the stone quarried at Little Falls was used in the new brownstone apartment buildings so popular in upscale Manhattan, N.Y., neighborhoods of that century, and it was used for Richard Upjohn's rebuilt Trinity Church in that city (1846). The last buildings to be built of this Little Falls brownstone were the buildings of the East Jersey Water Co. in 1898.

The intake, pump station, and associated boiler house built by the East Jersey Water Co. over 100 years ago still stand at Little Falls today (see the photograph on the opposite page); they are now owned and operated by the Passaic Valley Water Commission. Thankfully, 20th-century science and engineering have more than once improved upon this venerable site, to the benefit of the more than 500,000 residents of northern New Jersey who are now supplied with water treated at the Little Falls plant.

FILTRATION AND THE DEMANDS OF PUBLIC HEALTH

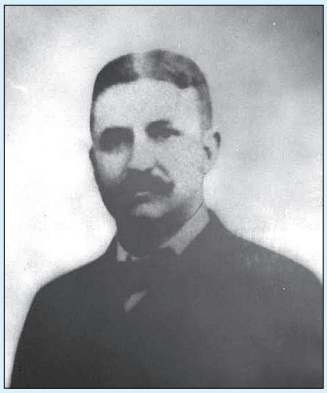
Even as the new pump station began service in 1898, it was recognized that improvements in water quality were necessary regardless of whether the river intake was upstream of the nearby urban environment. By 1900, engineers and public health experts understood the hazards associated with drinking untreated surface water, and of

George Warren Fuller (1868–1934)

G.W. Fuller's experiments at Lawrence (Mass.), Louisville (Ky.), and Cincinnati (Ohio) established the principles for rapid sand filtration to be used throughout the world. He pulled together the latest advances in mechanical filtration and gave them their first full-scale implementation at the Little Falls Water Treatment Plant in Totowa, N.J., in 1901. This was one of the first contracts for Fuller's new Manhattan, N.Y.–based consulting practice. The firm of Hering and Fuller, having designed the alum feed system for Little Falls, collaborated with John L. Leal when Leal needed to implement a full-scale, continuous chlorination feed system for the East Jersey Water Co. at its Boonton reservoir. As the well-known history goes, Fuller went on to become one of the world's foremost engineers in water supply and sewerage management.

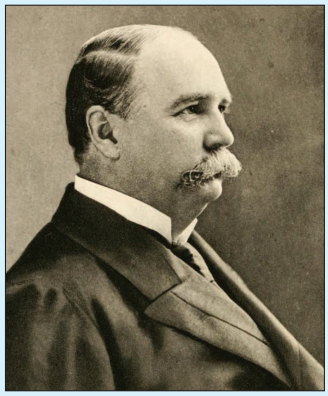
Photo source: Writers' Press Association, 1903.

John L. Leal (1858–1914)



From 1884, when he received his medical degree from Colombia College of Physicians and Surgeons, through the remainder of the 19th century, John L. Leal was prominent in protecting and improving public health in Paterson, N.J., as city physician, health inspector, and health officer. His expertise made him a valuable asset as he expanded his career, from 1899 onward, to advise water companies on sanitary practices. His participation in developing chlorination of drinking water for disease prevention—and in persuading a skeptical public of its value—have been documented elsewhere (McGuire 2013). As sanitary advisor to the East Jersey Water Co., Leal worked at the Little Falls facility and installed one of the first American chlorination systems there in 1908. Leal's grave monument in Paterson's Cedar Lawn Cemetery hails him as a true "Hero of Public Health."

Garret Augustus Hobart (1844–1899)



A name not commonly associated with the history of water treatment, Garret Hobart nevertheless participated in two significant ways to the development and processes of the Little Falls Water Treatment Plant in Totowa, N.J. An 1863 graduate of Rutgers College (New Brunswick, N.J.), Hobart became one of Paterson's most successful sons as a lawyer, banker, and capitalist. He was instrumental in reworking the finances of the struggling Passaic Water Co. into the syndicate that emerged later as the giant East Jersey Water Co. that built, among other lasting structures, the Little Falls pumping and filtration plant. As a prominent Patersonian, Hobart was a natural mentor to the young Paterson health officer John L. Leal. He led Leal to participate in water treatment improvements not only in New Jersey but around the country, and Leal served as a valuable advisor to Hobart in matters of public health. Incidentally, Hobart, who participated in politics "for relaxation," served as vice-president of the United States under William McKinley, and upon McKinley's death would likely have become president himself, had he survived, instead of Theodore Roosevelt.

Source: Magie 1910.

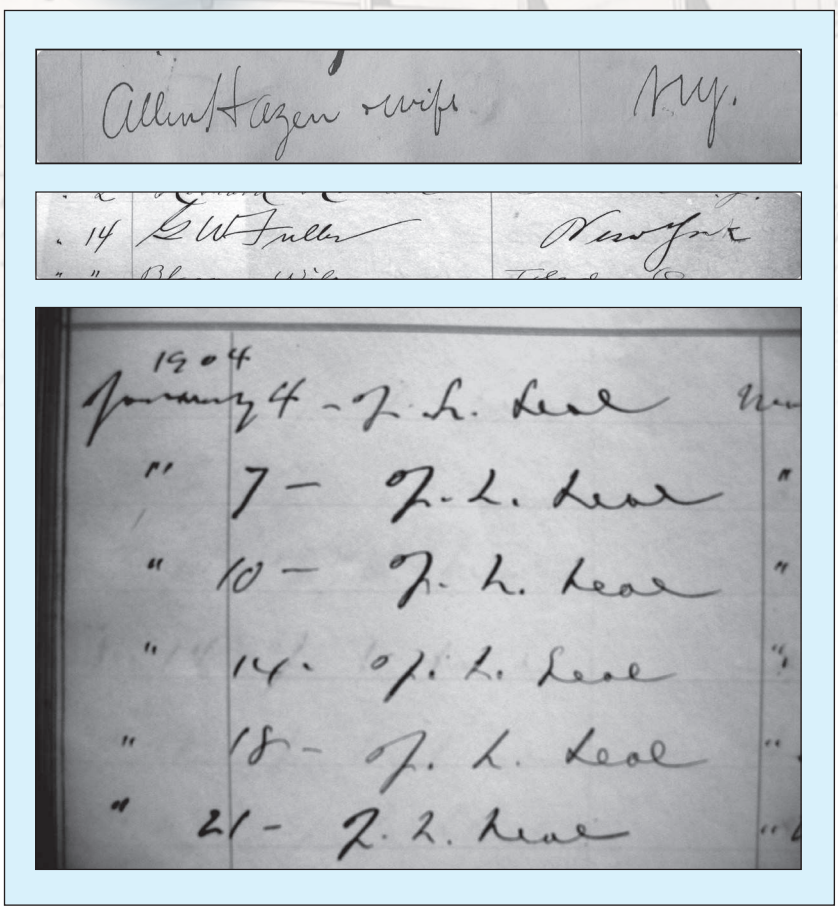
course any consumer could tell the difference between drinking untreated river water and clean well water, at that time considered the standard of high water quality. In 1901 construction began on a filtration plant that would drive dramatic improvement in delivered water quality.

For several decades earlier, slow sand filtration had been implemented in the United States, modeled after English systems of that type. But the demands of a larger population, drawing water from a sometimes turbid river supply, required that the newer technique of rapid filtration be implemented at Little Falls. The East Jersey Water Co. called upon the engineering prowess of George W. Fuller (see the sidebar on page 72), from nearby New York City, to meet these demands. In one of the earliest consulting projects for his new Manhattan-based practice, Fuller led the design for Little Falls of what would become the first large-scale rapid sand filtration plant in the world. His new plant incorporated the process innovations that had been studied and developed in depth during the experiments of earlier years that took place in Lawrence, Mass., Louisville, Ky., and Cincinnati, Ohio. The Little Falls plant, in the words of Moses Baker (1981), "inaugurated a new era in the design of rapid filters."

"As a matter of fact, Paterson's water supply is regarded as the equal to the best in the country," according to Nelson and Shriner (1920); ". . . the water which is pumped into the reservoirs near Little Falls is filtered and sterilized; there has not been for many years a case of typhoid fever—that supreme test of the purity of a water supply—in Paterson that could not be traced to some cause other than the water from the river."

Fuller's design incorporated integrated coagulation and sedimentation basins and used specially controlled air and water flows through underdrains to optimize filter backwash. The design introduced a rectangular, concrete filter with common-wall construction that evolved into the industry standard, and it optimized operator control through the use of hydraulically operated control valves. The new filter building was, incidentally, also one of the first industrial buildings in the United States to be built out of reinforced concrete. And in addition to these advances, Fuller incorporated a particularly successful alum feed design that would impact water treatment more profoundly than he recognized at the time.

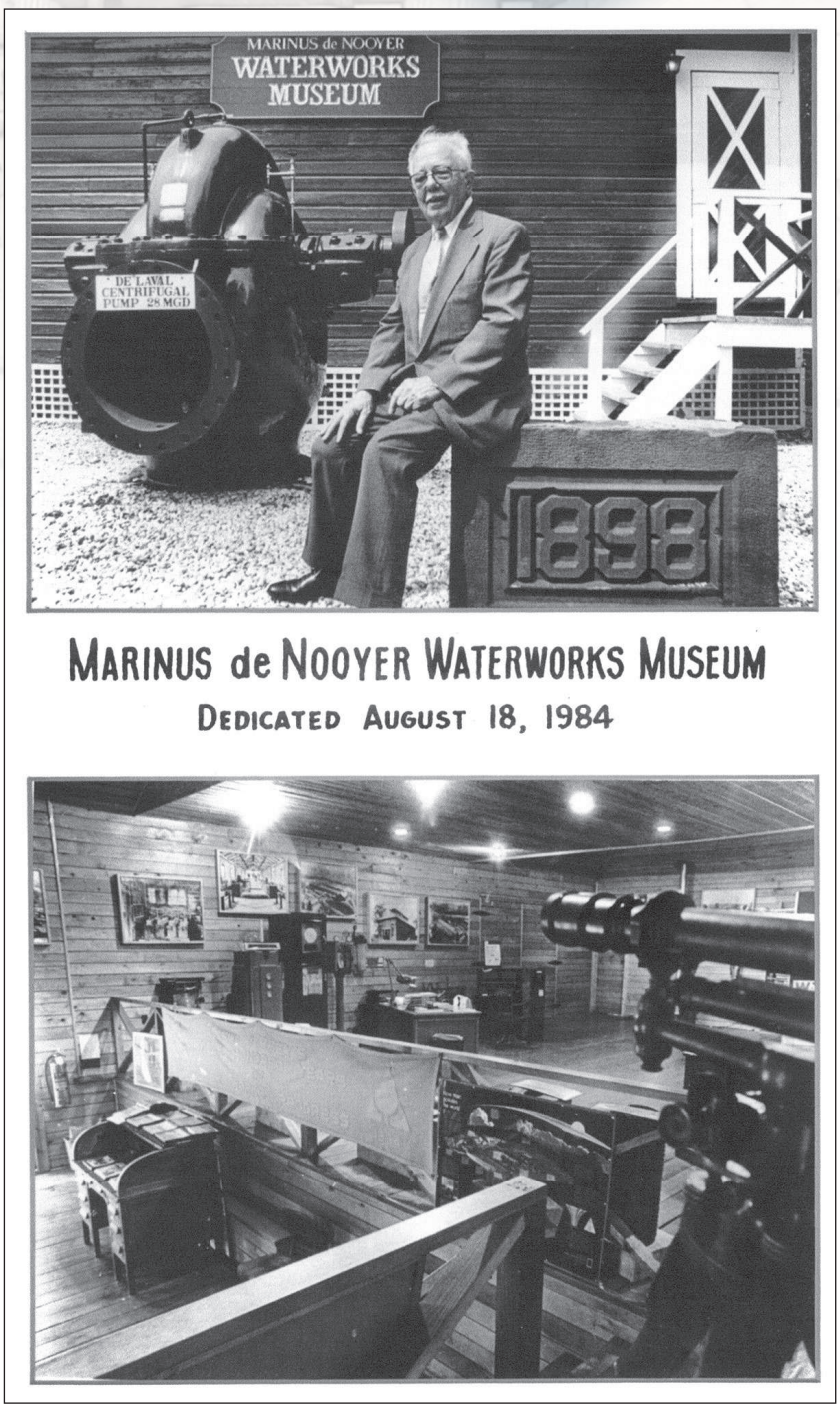
Critical to the success of Fuller's new filters was the proper grading of the sand that was used. This was finally mastered through the techniques of Allen Hazen, whose signature, like Fuller's, can be found in the historical log books of the Little Falls facility (see the photographs on this page). Hazen, who was inducted into AWWA's Water Industry Hall of Fame along with Fuller, could not find a reliable supply of properly graded sand and eventually took to settling the sand in place and gradually removing the fines manually from the top of each bed. In 1913 a major upgrade was undertaken to add new sedimentation basins and increase capacity by 10 mgd. By 1918 an additional 10 filters were in operation.



Top: Allen Hazen was a frequent visitor to the Little Falls Water Treatment Plant as he worked to optimize the sand specifications for the new filters, and his signature can be seen in the historical log books. Center: The engineering genius at the foundation of the East Jersey Water Co. Filtration Works, George W. Fuller, signed the visitor's log on Mar. 14, 1905. Bottom: The energetic and conscientious sanitary advisor to the East Jersey Water Co., John L. Leal, signed in every few days as he reported for work at the Little Falls Water Treatment Plant.
Photos courtesy of the Passaic Valley Water Commission.

THE DOCTOR MAKES A HOUSE CALL

Paterson produced more in the 19th century than world-class locomotives, silk, revolvers, and river pollution. It also launched the career of the man



Top: Marinus de Nooyer at his Water Works Museum at Little Falls. Bottom: The museum's interior in 1984. *Photo courtesy of the Passaic Valley Water Commission.*

recently recognized as a true hero of public health, Dr. John L. Leal (see the sidebar on page 72). Under the mentorship of another prominent Patersonian, Garret A. Hobart (whose profile is in the same sidebar), Leal transitioned from serving as Paterson's energetic public health officer to becoming a sanitary advisor to the East Jersey Water Co. and other large water companies.

In the back pages of the Little Falls visitor's log of 1904 appear Leal's signatures (see the photograph on page 73), which he would have put down on paper as he stopped by to check the performance of the filtration plant and possibly to conduct bacteriological experiments, which are now recognized for helping to alter the course of American water treatment. He recognized from his own studies, and the work of others in the field, the potential that using chlorine disinfection of drinking water held for public health. During his work at Little Falls, Leal surely observed firsthand the successful operation of Fuller's mechanical alum feed process, and it's easy to imagine him envisioning the use of just such a process for his chloride of lime dosing. These activities at Little Falls (along with news of disinfection installations in Belgium and England) no doubt contributed to Leal's confidence in persuading the participants in the famous Jersey City water trial of 1908 to initiate permanent chlorination at the Boonton supply for that city, and then to enlist the immediate services of Fuller's engineering firm in designing, building, and operating the Boonton chlorine feed system.

In fact, Sept. 26, 1908, is the day that the Jersey City Water Supply Co. implemented a permanent chlorination process for the Jersey City water supply and inaugurated the practice as a fixture in the treatment of American drinking water. As can be read in Leal's testimony at the second Jersey City trial that took place on Feb. 4, 1909, he had also installed a similar system at the Little Falls plant "some months prior" to that date, he had experimented with it there, and it was "now in daily use." Chlorination at the Little Falls facility evidently followed very quickly in the wake of the Boonton installation, basically as an extension of the same project undertaken by these luminaries in the history of American water treatment. As noted by McGuire (2013), this history shows that Little Falls saw the first marriage of chlorination and rapid sand filtration.

WATER'S "WISE OLD MAN"

In August 1984, top officials of the Passaic Valley Water Commission gathered at a small building on the

Little Falls grounds, formerly just a freight station on the plant railroad spur, to dedicate it as the "Marinus de Nooyer Water Works Museum" (see the photographs on page 74 and at right). It was a fitting recognition of the imagination and energy brought to the Commission and to the world of water treatment by the man himself.

de Nooyer was among the great wave of Europeans who immigrated to the United States in 1905, and he was born a Dutchman (which he later pointed out with pride) seven years earlier. Somehow his 40-year career as a wool-spinner prepared him for service in the water industry after his retirement at age 60, because he joined the board of the Passaic Valley Water Commission shortly thereafter and served from 1958 to 1962. He was a principal driving force in expanding the commission's water capacity by creating its Point View reservoir. Eight years later, he returned for a stint as senior research assistant and was rehired yet again at the age of 85 as special consultant, chief investigator, claims adjuster, tour guide, and lecturer.

de Nooyer came up with the idea for a water works museum in the early 1970s, and he began collecting artifacts that he and his coworkers managed to ferret out of the various storerooms and file cabinets around the 80-plus-year-old water company. Maps, schematics, photos, drawings, pay-books, billing records, pipes, legal transcripts, chemicals, and chlorination equipment all found a home in his collection. Also, the law library of the Collins and Corbin law firm (longtime attorneys for the East Jersey Water Co.) was included in the museum, setting the stage for the 2008 discovery of complete transcripts of the Jersey City trials (McGuire 2013). de Nooyer brought his personality as a poet, historian, and hard worker to the task of creating his museum, and the little red building and its contents still stand on the grounds of the Little Falls Water Treatment Plant.

de Nooyer passed away in 2002 at the age of 104. He is remembered not only at Little Falls but also at Ellis Island, where he provided an audiotape and a videotape for the Ellis Island Foundation. He was invited back there in April 2001 by the Foundation for the ceremonies to introduce their searchable ship manifests. His arrival in the United States was one of the first arrivals queried to demonstrate the new database that day.

The Marinus de Nooyer Water Works Museum still stands today on the grounds of the Little Falls Water Treatment Plant. *Photo courtesy of the Passaic Valley Water Commission.*

HISTORY REPEATS

After the Little Falls filtration plant began service, it drew visitors and attention from across the country, and in fact across the globe, as a working model for modern water treatment. Here was a full-scale implementation of the studies and experiments conducted so carefully in the latter years of the old century. Visitors from Tokyo, Japan, having observed firsthand the new design, persuaded their city to build a virtual replica of the Little Falls plant for their water treatment needs.

As the plant aged through the course of the 20th century, and as technology advanced, the need for renewal returned to Little Falls. In the mid-1960s, the 1918 filter extension was removed and replaced with a modern facility, and by the 1980s it was clear that the original 80-year-old filtration apparatus had served its useful lifespan. The above-ground structure was demolished down to its foundation, but the original filter boxes, with their clearwells below, were retained (see the photograph on page 76). The new filtration building, which stands today, rose on the footprint of the old in 1986.

It was at the turn of the new century that history began repeating itself. The continuous development of regulations pursuant to the Safe Drinking Water Act had combined with growing awareness of more minute and varied contaminants potentially present in a supply such as the Passaic River. Once again, the drive to apply world-class treatment technology found its realization at Little Falls. To optimize particle removal and meet updated finished-water turbidity requirements, the old, leisurely, and sometimes temperamental coagulation equipment was replaced with a fast, efficient, and modern sand-ballasted process.[1] The new demands to reduce disinfection by-products and the interest in applying advanced oxidation prompted the switch from chlorine primary disinfection to a modern ozone generation and contact process. All of the filters, from both the 1966 and the 1986 upgrades, were completely refurbished with modern underdrains and

The interior of one wing of Fuller's filter building, c. 1917. The exterior walls and steel trusses were removed in 1986, but the concrete filter boxes and clearwells beneath remain in service today. *Photo courtesy of the Passaic Valley Water Commission.*

outfitted with granular activated carbon to optimize trace contaminant removal. Modern water-quality monitoring devices and supervisory control and data acquisition were installed throughout, and the New Jersey certified water quality laboratory was completely renovated and modernized. Somewhat incredibly, this entire rework of the Little Falls water treatment process and physical plant, exactly on the existing footprint, was accomplished while the plant itself was still in operation, supplying drinking water to half a million water consumers across northern New Jersey.

Thus, Little Falls witnessed at the outset of the new century a reenactment of what had taken place 100 years before at the same location: the implementation and full-scale assembly of the most modern water treatment technologies that were developed in the years just before. Working at a scale reminiscent of Fuller's filters 100 years before, the Passaic Valley Water Commission had implemented at Little Falls the highest-volume sand-ballasted drinking water plant in North America at that time, and one of the largest in the world. It incorporated once again a disinfection technology demonstrated to be effective in protection of public health, both microbiologically and with an eye on emerging chemical contaminants. The entire process was envisioned and designed to meet the specific treatment needs of its source water, the Passaic River, not only on the day of opening but for decades into the future. As their predecessors had done a century before, visitors from across the country and the globe traveled to Little Falls to observe and study the new installation at the intersection of history and innovation.

ACKNOWLEDGMENT

The author gratefully acknowledges the many helpful, interesting, and enlightening contributions to this history that were provided by Joe Bella and Cindy Reinhart of the Passaic Valley Water Commission and by Laura Cummings of the Southeast Morris County Municipal Utilities Authority.

ENDNOTE

[1]ACTIFLO®, Veolia Water Technologies, Plainfield, Ill.

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IN THE SPOTLIGHT

Journal AWWA is seeking submissions and nominations for the regular feature series, "Spotlight On . . . ". This series started in April 2015 to showcase water facilities in North America that demonstrate historical importance, architectural excellence, and technological significance. To submit an article or to nominate a facility, contact Editor-in-Chief Mike McGuire at journaleditor@awwa.org.