The Old Croton Aqueduct

Rural Resources Meet Urban Needs

The Hudson River Museum of Westchester

The Old Croton Aqueduct

figure 1: **Section of the Aqueduct with Iron Lining**, c.1837-39, ink and watercolor on paper
Courtesy Jervis Public Library, drawing #205. Photo G. R. Farley

The Hudson River Museum of Westchester

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On the cover:

David Johnson, **High Bridge**, c.1860, oil on paper
Courtesy Dana and Jeffrey Cooley

Elevation of A High Bridge for Crossing Hariaem [sic] **River**, c.1839-40
watercolor and ink on paper
Courtesy Jervis Public Library, Rome, NY. Photo: G.R. Farley

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The Hudson River Museum of Westchester Yonkers, New York 1992

figure 2: Fayette B. Tower, **View above the Dam**, in *Illustrations of the Croton Aqueduct*, 1843, engraved by William James Bennett
Courtesy The Historical Society of the Tarrytowns (different version in exhibition). Photo: J. Kennedy

Contents

The exhibit and accompanying publication commemorating the 150th anniversary of the Old Croton Aqueduct bring to life the rich and complex story involving one of the great public works projects of its time. The need to supply New York City with clean water, the technical challenge of meeting this demand and the human drama of both the communities and individuals involved are interwoven into an engaging narrative which not only tells much about local history here, in Westchester County, but also reflects on a growing region and nation during the middle part of the 19th century. And although the Aqueduct is no longer operational and its most visible presence is that of a nature path traversing 13 County municipalities, its role in defining both Westchester and New York City are considerable and enduring.

The tremendous effort in organizing and implementing such a project required much time and participation by many individuals; all are to be congratulated for bringing the story of the Aqueduct to its successful realization. First and foremost, let me acknowledge the leading role and guiding spirit provided by the exhibit's co-curators Laura Vookles Hardin, the Museum's Curator of Collections, and Tema Harnik, Administrative Director of the Lower Hudson Conference. Both have worked long and tirelessly in locating key loans, preparing catalogue essays and assembling a support team of multi-disciplinary professionals who have assisted the project through participating in a scholars symposium and/or contributing essays to the catalogue. These include Dr. Emory Kemp, Professor of History and Preservation of Engineering Works at West Virginia University; Dr. Jeffrey A. Kroessler, School of General Studies, Adelphi University, and History Department, Queens College, CUNY; Dr. F. Daniel Larkin, Professor of History and Chairman of the History Department at SUNY Oneonta; and Roger Panetta, Professor of History at Marymount College. Daniel Walkowitz, Professor of Urban and Labor History in New York State and Director of Metropolitan Studies Program, New York University, served as editor.

Others who participated in the symposium include Judy Brewton; William Lee Frost; Kenneth Lutters, Senior Landscape Architect, New York State Office of Parks, Recreation, and Historic Preservation; and Carl Oeschner, Educator, Ossining.

Rusty Russell produced and Judy Brewton scripted a video which has been integrated into the exhibit.

In addition to Ms. Hardin, all staff members from the Museum's Curatorial and Education departments contributed in many ways to the project, particularly John Matherly, Director of Design, and Margo Williams, Registrar.

I wish to thank all of those individuals and organizations which made loans to the exhibition and provided additional research materials. All lenders are listed elsewhere in this catalogue.

Finally, I wish to acknowledge and thank those funding sources which generously supported the project through both its planning and implementation phases: the National Endowment for the Humanities, a federal agency; the New York State Council on the Arts; and the New York Council for the Humanities.

Philip Verre, Director

figure 3: James Renwick, Jr., **Frontispiece of report by John B. Jervis to Water Commissioners**, c.1837-40, watercolor on paper in "Letter Book of John B. Jervis" (vol. III), (not in exhibition)
Courtesy Jervis Public Library. Photo: G. R. Farley

WATER FOR THE CITY

Jeffrey A. Kroessler

figure 4: C. Bachman, **New-York** (Croton water fountain and view to tip of Manhattan), 1849, lithograph of Sarony & Major, NY, published by John Bachman, NY
The Hudson River Museum of Westchester, 74.0.49. Photo: J. Kennedy

During the first half of the 19th century New York City emerged as the nation's pre-eminent metropolis. The 1810 census revealed that New York had passed Philadelphia to become the nation's largest city, and by 1830 it had surpassed Mexico City to become the most populous city in the hemisphere, a fact which would hold true for more than a century. By 1850, the population of Manhattan approached half a million.[1] But more than sheer numbers put Manhattan atop the country's hierarchy of cities. Gotham—a term first used by the era's celebrated man of letters, Washington Irving—set the pace, and its vitality both fascinated and repelled American and foreign visitors.

In the decades before the Civil War, New York's merchants dominated the trans-Atlantic trade as well as most of the nation's domestic commerce. Whether measured in ship tonnage or the total amount of imports and exports, New York was clearly the hemisphere's busiest port. The City rushed ahead of its rivals immediately after the War of 1812, when British merchants dumped manufactured goods that had piled up during the war. The introduction of regularly scheduled packet service to English ports, beginning with the Black Ball Line in 1818, enhanced New York's position by allowing merchants to ship their goods in a timely fashion, rather than waiting until a vessel had a full cargo (figure 5).

Completion of the Erie Canal in 1825, which linked New York directly to the Great Lakes and Ohio, and the City's domination of the cotton trade from southern ports, also factored into the City's rise to commercial power. Agents representing New York firms handled all aspects of the cotton trade, from insurance and financing to shipping and sale at the other end. Most of the bales were shipped on New York bottoms to Europe and New England, and manufactured goods passed through the port in the opposite direction. In banking and insurance, too, New Yorkers held national supremacy. New York's banks set the rates for smaller ones in the south and west, and events in the City had financial repercussions across the country.

New York grew faster than any other American city. Adoption of the Commissioners Plan in 1807, which set a street grid over

Manhattan from 14th to 155th Streets, facilitated the rapid development and leveling of the island, without regard for such topographic features as hills, swamps, streams, springs, or natural drainage. Conspicuously absent, of course, was any provision for public parks, and it is truly one of the triumphs of the 19th century that the City had the energy and foresight to create Central Park in the 1850s.

By mid-century, the built up portion of Manhattan extended four miles along each river, and across the river on Long Island, Brooklyn and Williamsburgh grew at an equally rapid pace. Between 1820 and 1850, Brooklyn's population increased from 7,715 to 96,838, and Williamsburgh exploded in the 1840s from only 5,094 to over 30,000:

Population	New York City	Brooklyn	Williamsburgh
1800	60,489	2,378	
1810	96,373	4,402	
1820	123,706	7,175	
1830	202,589	15,394	
1840	312,710	36,233	5,094
1850	515,547	96,838	30,780

Note: The city of Williamsburgh was created in 1839 from part of the town of Bushwick, and was annexed by Brooklyn in 1854.
Source: *Census of the State of New York for 1855* (Albany, NY, 1857)

The growth of industry in the rising commercial entrepot required a labor force, and immigrants who passed through the City provided an ample and cheap supply. More than half of all immigrants landed in the City, and though most of them moved on, the influx certainly added an ethnic dimension to the urban scene.[2] By 1830

figure 5, above: C. Burton, **Steam Boat Wharf, Whitehall Street** (New York), 1831, engraved by George W. Hatch and James Smillie, printed by James R. Burton, published by G. Melksham Bourne
The Hudson River Museum of Westchester (not in exhibition)
Photo: J. Kennedy

figure 6, right: Nicolino V. Calyo, **The Great Fire of 1835 ... Burning of the Merchants Exchange, NY, Dec. 16, 17, 1835**, gouache on paper
Courtesy Museum of the City of New York, Bequest of Mrs. J. Insley Blair, in Memory of Mr. and Mrs. J. Insley Blair, 52.100.7

New York City held 16.5% of all the aliens in the country, and almost half of the nation's total lived in the Empire State. The 1860 census would reveal the majority of New York's population to be foreign born, and fully three-fourths were of foreign stock.[3]

With the Irish accounting for over a quarter of Manhattan's population in the 1830s, native-born Americans not surprisingly saw the ethnic, and religious, characteristics of the newcomers as a threat to their control over the metropolis. Thus, the decades of the Jacksonian era saw commercial growth amidst new social cleavages along racial, ethnic, and class lines.

This was the city which built the Croton Aqueduct. The lack of an adequate water supply obviously did not hinder the spectacular growth of the metropolis, but the citizens of the nation's largest city had to endure a dirty, smelly, disease-ridden, and fire-prone environment.

Fire and disease were the twin demons of cities, and a ready supply of water promised to vanquish them both. Since the buildings were built of wood, and fireplaces were used for cooking and heating, fires rapidly spread to disastrous proportions. One fire in 1776, during the British occupation, destroyed almost a quarter of the entire city, and almost every year saw a conflagration which took the better part of a block; there were 110 fires in 1834 alone. But the fire of December 1835 was by far the most destructive. It consumed 17 blocks and parts of several others, destroying 654 stores, residences, and public buildings, among them the Merchants Exchange, the South Reformed Dutch Church, and most of the structures surviving from the Dutch era (figure 6). Although fire companies arrived on the scene and manfully fought the blaze, their efforts were futile. The night was so cold that water froze in the fire hoses. The fire wiped out businesses, leaving thousands of New Yorkers without jobs, and caused the failure of most of the City's insurance companies, a major cause of the disastrous Panic of 1837.[4]

An adequate water supply also promised to improve the City's disease environment. Epidemics regularly visited the metropolis, and medical experts drew the obvious connection between living conditions and contagion. Yellow fever broke out repeatedly in the 1790s and early 1800s. The epidemic of 1798 took the lives of 2,000 New Yorkers. Writing to Noah Webster, Dr. Samuel L. Mitchill, one of the City's leading men of science, blamed urban

conditions for the outbreak: "New York this time has a plague indeed. The scourge is applied severely and cuts deep.... It seems to be admitted on all sides to be a home-bred Pestilence. The inhabitants have really poisoned their city by the accumulation of Excrement, putrid Provisions, and every unclean thing." Prominent citizens who investigated that epidemic offered a series of recommendations for preventing similar outbreaks in the future, and a water system was among the most important: "In suggesting the means of removing the causes of pestilential diseases, we consider a plentiful supply of water as one of the most powerful, and earnestly recommend that some plan for its introduction into this city, be carried into execution as soon as possible."[5]

If any citizens still doubted the connection between "pure and wholesome water" and the City's disease environment, the cholera epidemic of 1832 provided convincing evidence. When news came that the dreaded disease had appeared in Montreal, all knew that it was only a matter of weeks before it arrived in New York. Anticipating the worst, the city government embarked on a radical street cleaning campaign. A contemporary noted with amazement: "The first thorough cleaning she ever had, was in the summer of that year; and for this cleansing the cholera is to be thanked .... For the first time, within the memory of living man, the stones of the pavements every where showed their heads ... they were first scraped and swept clean; and the filth carted away."[6]

Despite the unprecedented precautions, the epidemic arrived in late June and spread rapidly, especially in the poorer districts which relied on badly polluted wells. Wealthier residents left the City for the duration. Former mayor Philip Hone removed his family to Rockaway in July. "The disease is here in all its violence and will increase," he wrote in his diary. "God grant that its ravages may be confined, and its visit short!"[7] By the time the epidemic subsided in October, there had been almost 3,000 fatalities of nearly 6,000 reported cases, and as many as 100,000 New Yorkers fled the City for outlying villages. By contrast, the epidemic was far less severe in Philadelphia, which suffered only 900 dead. The difference was accounted for by the liberal use of water to wash the streets, a health measure possible only because in 1822, Philadelphia had become the first American city to complete a municipal water system.[8]

Even before the end of the 18th century, the need for a reliable stream of water had become a public issue in New York, not only to protect the health and welfare of the citizenry, but also to ensure the City's commercial supremacy. In 1798, the *New York Daily Advertiser* asked: "Citizens of New York, what are you doing? ... If you procrastinate, you are ruined; while you are immersed in business or sunk in pleasure, careless of the future, other towns, your rivals in trade, have vigorously begun the most effectual measures of precaution."[9]

Public wells and pumps were long established in the City, the first dating from 1658. By 1809, there were 249 public wells, but the quality was uniformly poor. The tea-water pump, for example, was dug in 1797 (figure 7). The well was 20 feet deep and four feet around, and yielded about 110 hogsheads (130 gallons each) daily. The water was sold door to door for a penny a gallon. Despite its popularity, however, the tea-water was far from pure, for it was located near the Collect.

The Collect, the once-pristine pond located at what is now Foley Square, was polluted beyond redemption (figure 8). As early as 1798 it was described as a "shocking hole, where all impure things center together and engender the worst of unwholesome productions." For years it had been used as a dumping ground for household garbage, sewage, and dead animals. Once on the outskirts of the City, the pond had by the early 19th century been enveloped by it, and the backyard privies in the adjacent neighborhood leached their noxious contents into the soil, contaminating the rainwater that filtered through and drained into it. In 1809 a canal was dug to the Hudson to drain the Collect and the spring-fed marshes near Broadway. By 1815, the Collect had disappeared, but Canal Street remained.[10]

Writing after completion of the Croton system, Dr. Charles A. Lee concluded that without the new aqueduct, the City's water supply would have soon been inadequate, for the quality had been steadily deteriorating for decades:

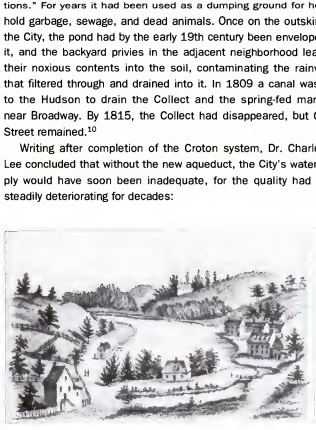


figure 7, above: **The Tea Water Pump at Roosevelt and Chatham Streets**, engraving
Courtesy the Museum of the City of New York

figure 8, right: **The Collect Pond**, c.1800, lllustration #17, *Hollyer's Old New York Views*
Courtesy The New-York Historical Society

It is fearful to contemplate the amount of decomposing organic matter contained in the wells in the vicinity of Trinity, St. Paul's, and St. John's burying grounds, which for more than a century furnished the only water used by those residing in their neighborhood. No one can doubt that the use of such water, as well as that from the wells on the Collect, and over the greater portion of the city below Canal-Street, must have proved extremely detrimental to the health of the citizens, and especially to children, and infants.[11]

For everyday purposes, such as washing clothes or floors, New Yorkers relied on the cisterns which held rainwater, but even this source deteriorated as the population increased. A guidebook published in 1837 complained:

The best water for washing in New York, is that which comes from the clouds. And indeed, nothing could be better, if you could catch it pure, as it falls. But in passing over the roofs of the houses, from whence it is conveyed to the cisterns, it contracts so much foulness from the coal-ashes and soot on the roofs, that its appearance is nearly as dark as ink, and its smell any thing but agreeable, as it comes in contact with your nose, in the operation of washing your face.[12]

The City received several proposals for a water system in the 1790s, but the government was reluctant to increase taxes to finance the effort. Still, whenever the subject arose there was general agreement that the system must be a municipal enterprise, rather than a privilege granted to a private company. In December 1798, the Common Council accepted a plan to tap the Bronx River, which they believed would "afford a copious supply of pure and wholesome Water." The Council urged that the appropriate legislation be introduced in Albany (at that time, the City had limited power over its own affairs, and for all important measures it had to gain approval of the state legislature). In endorsing the proposed water works, the Common Council specifically rejected the possibility of a private corporation receiving the franchise, reasoning that such a company would not undertake the project "unless upon the Prospect of considerable Gain; and such Gain must be acquired at the Expense of the City." A bill was prepared, and had events continued along this path, New York would have become the first city in the republic with a municipal system.

In Albany, the bill underwent a metamorphosis, and when it emerged it had created the Manhattan Water Company. Aaron Burr, the influential New York lawyer and leader of the City's Jeffersonian faction, first blocked the bill, and then, enlisting the aid of Alexander Hamilton and other influential Federalists, submitted a new version which granted exclusive rights to his corporation. For his part, Hamilton favored on principle the private sector over public ownership. Burr was not interested in water, of course. At that time, all the banks in the City were controlled by his political rivals, the Federalists. Burr had inserted a clause in the Manhattan Water Company charter that permitted the company to invest surplus capital "in the purchase of public or other stock, or any other moneyed transactions or operations ...." In other words, the Manhattan Company could function as a bank so long as it fulfilled its chartered obligation to supply water to all citizens who wanted it.[13]

The company quickly confirmed the worst fears of its critics by abandoning plans to tap the Bronx River and, instead, drilling a well at Reade and Center Streets in a densely populated neighborhood.

figure 9: **Hollow Log with Valve, used by The Manhattan Water Company, N.Y.C.**, wood and iron
Courtesy The New-York Historical Society, X.47

They also constructed a 132,600-gallon reservoir on Chambers Street, an obviously inadequate supply given an estimated need of 3 million gallons daily. Finally, rather than install iron pipes, the company used the cheaper, if time-tested alternative of hollowed logs (figure 9). In sum, there were few pipes, little water, and even that was of questionable quality. Furthermore, the charter did not limit the rates, nor did it include provisions that the company supply water for such legitimate municipal needs as flushing the streets or firefighting, or even that the company repair the streets after digging them up to install the pipes. The pipes extended only to those neighborhoods where the company expected it could make a profit, leaving more than a third of the built up areas without service. When the company finally did begin replacing the hollow logs with iron, they neglected to install hydrants for firefighting, forcing the City to construct 40 large cisterns for that purpose.

Even with all their cost-cutting measures, the Manhattan Company collected only $10,000 a year in water rents; at the same time, the door to door water business amounted to $273,750! Conditions in the 1820s were worse than at the end of the 18th century, and Burr's company was the major impediment to securing a water supply. As one observer noted in the 1830s, "There is not perhaps in the Union a city more destitute of the blessing of good water than New-York."[14]

The epidemic of 1832 was so devastating that after New York's system was completed, many credited the "frightful ravages of the cholera" with arousing "the minds of the citizens" to the importance of pure water. In early 1833, the Common Council requested that Albany pass legislation providing for the appointment of a water commission "to examine and consider all matters relative to supplying the city of New-York with a sufficient quantity of pure and wholesome water for the use of its inhabitants," and allocate funds for that purpose. In 1834 the Common Council again appealed to Albany for the right to borrow $2.5 million for the contemplated water works, but the Legislature lacked confidence in the City's ability to carry the project forward and instead authorized the appointment of an independent Water Commission. The bill signed by Governor William Marcy on May 4th required the Commission to report to the Council with plans, budgets, and an estimate of anticipated revenues, but also demanded that the voters have the final say.[15]

In July the Council allocated $5,000 for surveys, and on February 16, 1835, the report was ready. Rejecting the Bronx River as yielding an inadequate supply, the Commissioners proposed tapping the Croton watershed. The estimated cost for a dam across the Croton River, the aqueduct, and reservoirs was $4,150,000, with an additional $1,262,000 for distributing pipes. They estimated the annual income, based on 30,000 customers, to be $310,000.[16]

Central to the report was the principle of municipal ownership, rejecting absolutely the possibility of another Manhattan Water Company: "Water is one of the elements, full and necessary to existence as light and air, and its supply, therefore, ought never be made a subject of trade or speculation." A report by the Committee on Fire and Water seconded that principle, while emphasizing that the water should be available to all, not just those who could afford to pay for it:

The control of the water of the City, should be in the hands of this Corporation, or in other words, in the hands of the people. From the wealthy and those who would require the luxury of having it delivered to their houses; and from the men of business, who would employ it in their work shops and factories, the revenue should be derived. But to the poor, and those who would be content to receive it from the hydrants at the corners and on the sidewalks, it should be as free as air, as a means of cleanliness, nourishment and health. In the hands of any other power than the Common Council, this free use would be restrained, and the experience of all other Cities (and our own may be included) teaches us the sad lesson that the trust of this power would be abused.[17]

In the three-day election that April, the voters overwhelmingly supported the proposal, 17,330 to 5,693, with only the three sparsely populated upper wards which were still blessed with relatively pure wells voting against the measure. At once the Common Council authorized the issue of $1 million in bonds paying 5% inter-

est, to be redeemed in 1860. For financiers, the project offered a sound investment and fresh opportunities for speculation. The Panic of 1837 slowed but did not stop construction, though it did bring investment to a standstill. As a result, the City sold $1.2 million in bonds in Europe between 1838 and 1840. This only flooded the bond market, however, and depressed the price of the water bonds to $79, or $21 below par. Ultimately such financial mismanagement increased the total cost of the Croton system by $3 million, almost a quarter of the final cost.[18]

Citizens expected that the new water supply would have immediately beneficial effects, among them "increased comfort and health," and "superior cleanliness of the streets and the consequent purity of the atmosphere." They also anticipated a lessened danger of fire and lower insurance rates. Rates did indeed drop and, confident of a sound return, investors poured their capital into new insurance companies. Unfortunately, another fire in 1845, three years after the opening of the Croton system, destroyed many blocks in the business section below Wall Street, wiping out several of the new firms, but that was the last great conflagration in the century.[19]

Another benefit was the creation of public baths. The People's Washing and Bathing Establishment opened on Mott Street in 1852. This enterprise featured a separate "swimming bath" for boys and girls, costing 3¢, "closet baths" upstairs for men and women for 5¢, and laundry facilities on the third story, complete with tubs, hot water, drying racks, and irons. Immediately popular, it was soon one of the heaviest users of water in the City.[20]

Reform-minded New Yorkers believed that the introduction of "pure and wholesome water" would remove an excuse for the consumption of strong drink and lessen the unpleasant effects of public drunkenness, particularly among the lower classes. By one estimate, the City had over 2,000 dram shops and hundreds of grocery stores that also sold hard spirits. Hopes that more would imbibe "Adam's Ale" instead of strong drink were disappointed, however.[21] Croton water actually may have saved the City's breweries, for the local product had so deteriorated that beer-drinkers preferred Philadelphia brews over New York's own.

There was a decided improvement in the City's disease environment, though the impact was not immediate. In the decades prior to the introduction of Croton water, the death rate averaged below 30 per 1,000 inhabitants, except during the cholera years when the rate climbed to as many as 50 per 1,000. Ironically, the promise of improved living conditions for the working poor remained unfulfilled. The ratio worsened in the 1840s and 1850s after the opening of the Aqueduct to about 40 per 1,000, and in the cholera year of 1849 it surpassed 60 per 1,000. Of course, this did not affect all inhabitants equally, for while 12% of the native-born Americans who died that year fell to cholera, the rate rose to almost 40% among immigrants.[22]

The discrepancy resulted from the difference in living conditions, the Americans living in newer homes uptown, usually connected directly to the Croton system, beyond the congested immigrant neighborhoods downtown. Furthermore, the affluent left the City entirely during the disease-prone summer months.

The availability of Croton water was perhaps the only amenity for the residents of the teeming tenement districts below Canal Street. Between 1820 and 1850, the population density had intensified from 157 persons per block to 272 per block (those figures would pale compared to the terrible overcrowding of the late 19th century), and those people were using the same outdoor privies and cesspools. Few tenement owners willingly paid the $10 annual fee to connect their buildings to the Croton system, and conditions actually worsened in the succeeding decades. In 1857, two-thirds of all reported deaths were the children of foreign-born parents, and throughout that decade more than half the children died before their fifth birthday.[23]

The Croton Aqueduct itself became something of a tourist attraction. Many climbed atop the Distributing Reservoir on 42nd Street to enjoy the view of the City spread out before them, and the Harlem River High Bridge became a favorite destination. Picnickers could hire a hackney coach for $5, which included a two or three hour stay, or they could take an omnibus from the Harlem Railway terminal, for about 50¢ round trip. Writing soon after the system was finished,

Fayette B. Tower boasted that the Bridge would "stand as a monument of the genius and enterprize [sic] of the age," but, he noted, it should "be regarded among the fruits of that civil and religious liberty" established by the founders of the republic.[24]

The Croton Aqueduct was indeed a triumph of the age and a source of pride for New Yorkers, perhaps more so because it was undertaken and completed by the metropolis itself during a time of social, political, and economic uncertainty. Despite those conflicts, despite the financial mismanagement, and despite the fact that it was decades before the entire population enjoyed the benefits, the introduction of Croton water was a cause for celebration. Decades later, historians wrote:

Its accomplishment by a single city ... in a period of unprecedented commercial embarrassment, and in the face of vast natural obstacles, was a marvel for all future generations. Henceforward there would seem no project too bold nor enterprise too great for New York to undertake.[25]

16 It is scarcely possible to overestimate the impact "pure and wholesome water" had on the City. Croton water eased the dangers of fire and disease and generally improved the quality of life through better sanitation in the City. Had the decision been put off for even a decade, the quality of life would have deteriorated to such an extent as to bring into question New York's commercial supremacy.

Notes

1. Ira Rosenwaike, *Population History of New York City* (Syracuse: Syracuse University Press, 1972), p.33.

2. Robert Greenhalgh Albion, *The Rise of New York Port, 1815-1860* (Boston: Northeastern University Press, 1984 [1939]), Appendices I-V, XXVII-XXIX.

3. Rosenwaike, pp.33-39, 41.

4. *Map Showing the extent of the Great Fire which broke out about 9 O'clock on the night of the 16th December 1835, in theCity of New York* (New York: G. Hayward, [1836]); A. Greene, *A Glance at New York* (New York: A. Greene, 1837), pp.197-210.

5. Nelson Manfred Blake, *Water for Cities: A History of the Urban Water Supply Problem in the United States* (Syracuse: Syracuse University Press, 1956), pp.45-8.

6. Greene, pp.173-6.

7. Louis Auchincloss, *The Hone and Strong Diaries of Old Manhattan* (New York: Abbeville Press, 1989), p.23.

8. Fayette B. Tower, *Illustrations of the Croton Aqueduct* (New York: Wiley & Putnam, 1843), pp.61-3; James Grant Wilson, *The Memorial History of the City of New York, from its earliest settlement to the year 1892* (New York: New-York History Company, 1893), pp.338-9; Blake, pp.93, 131-3.

9. Blake, p.46.

10. John Duffy, *A History of Public Health in New York City, 1625-1866* (New York: Russell Sage Foundation, 1968), pp.195-9; Wilson, pp.203-5, 397.

11. Tower, Appendix, pp.138-9.

12. Greene, p.186.

13. Duffy, pp.202-7.

14. Greene, p.180; Blake, pp.50-1, 58-9, 107-8, 122-3, 134-5; Duffy, pp.195, 207.

15. Tower, pp.61-65.

16. Tower, pp.64-8; Blake, pp.138-42.

17. Blake, pp.140-1.

18. Blake, pp.141-2, 150-1, 170.

19. C. S. Francis, *Francis's New Guide to the Cities of New-York and Brooklyn, and the vicinity* (New York: C. S. Francis & Co., 1853), p.70; Mrs. Martha J. Lamb and Mrs. Burton Harrison, *History of the City of New York: Its Origin, Rise, and Progress* (New York: The A. S. Barnes Co., 1896 [1877]), p.747.

20. Francis, p.70.

21. Greene, pp.185-7.

22. Rosenwaike, p.37; Duffy, Appendix I.

23. Oliver E. Allen, *New York, New York: A History of the World's Most Exhilarating and Challenging City* (New York: Atheneum, 1990), p.151; George J. Lankevich and Howard B. Furer, *A Brief History of New York City* (Port Washington: Associated Faculty Press, Inc. 1984), p.93.

24. Tower, pp.110-111.

25. Lamb and Harrison, pp.730-2.

Preliminary Plans for the Old Croton Aqueduct and the Structure of its Engineering Department

F. Daniel Larkin

figure 10, above: **Portrait of Major David Bates Douglass**, contemporary print from glass plate negative
Courtesy The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges

figure 11, below: Frederick R. Spencer. **Portrait of John B. Jervis**, c.1837, oil on canvas
Courtesy Jervis Public Library, (on permanent loan from Addison White)
Photo: G. R. Farley

The return of the dreaded cholera in a raging epidemic in 1832 finally moved New York City's government leaders to renew and intensify their efforts to locate an adequate and continuous supply of fresh water for the metropolis. The loss of lives was nearly four times the death toll in Philadelphia, where the city regularly flushed the streets with water from the new Fairmont Works on the Schuylkill River. New York, with its 250,000 inhabitants, had to construct a supply system not only to meet the water consumption and health requirements of its burgeoning population, but also to serve the growing demands of its industrial and commercial expansion.

Actually, New York City's quest for water predated 1832 by more than half a century. As early as July 1774, the Common Council adopted the proposal of Christopher Colles to build a reservoir in lower Manhattan, supply it with water pumped from wells, and then distribute the water throughout the community. The expense of construction was to be borne by £5,100 in city treasury notes issued for that purpose. However, the onset of the War for Independence in 1775 ended the project. Between the mid-1780s and the end of the 18th century, numerous proposals for supplying water funneled into the Common Council from within Manhattan, from Upstate, and from out of state. Perhaps the most ingenious and simultaneously ingenuous was that of the self-serving political charlatan, Aaron Burr. Burr's plan was designed to provide him with a charter for a bank under the guise of furnishing water to the City. In its water search, the New York Common Council even sought the advice of William Weston, an English civil engineer in the United States to supervise some early canal construction. In 1799 Weston reported in favor of the Bronx River as an adequate source to supply the 3 million gallons per day that he estimated the City would need. Weston recommended an open aqueduct to bring the Bronx water to Manhattan. The Harlem River would be crossed by a cast iron pipe 2 feet in diameter. But, other than a large well sunk by Burr's Manhattan Company, virtually nothing was done to solve New York's growing water supply problem until after the War of 1812.

Beginning in 1816 committees were again appointed and experts hired to locate the long sought after abundant supply of pure water for New York City. During this round of recommendations, the renowned Erie Canal engineer, Benjamin Wright, was consulted. Wright, with his able associate Canvass White, reported in favor of the Bronx River with iron pipes being used for the Harlem River crossing. Thus by 1824 the focus was again on Bronx water as a solution to New York's supply problem. The water would be conveyed to Manhattan in a covered masonry conduit at a construction cost, including the pipes across the Harlem, of approximately $1.5 million. Again no action was taken and the City continued to rely on its insufficient and polluted wells.

Perhaps most novel among the early attempts to find enough water under Manhattan was that of Levi Disbrow in the 1820s. Disbrow drilled deeply into the island's rock to locate a supply of high quality water. His first hole produced an encouraging return at 442 feet, but successive drilling was less promising. Finally when mineral water was brought up from one of the wells, the Disbrow scheme went the way of all the others. By then, at the end of the 1820s, the City's fire department was adding its support to the growing appeal to solve the water supply problem. Conflagrations occurred with alarming regularity in the largely wooden metropolis and the firefighters had no sufficient supply of water on which to rely (figure 6).

At the beginning of 1832, the Common Council's Committee on Fire and Water hired Colonel DeWitt Clinton and instructed him to examine the Croton River in northern Westchester County as a possible source. Clinton's report was a solid recommendation in favor of the Croton, a departure from the advice of all the preceding engineers charged with exploring for a water source. In fact, while Clinton was advocating the Croton as the place to get water, a simultaneous survey under the direction of Benjamin Wright, then New York City Street Commissioner, again heralded the virtues of the Bronx River, particularly the frugality of construction costs.

In 1833, the Common Council succeeded in getting a Board of Water Commissioners appointed whose task was to determine a sufficient water source and agree on a manner to convey the water to New York City. Several surveys were made to decide between

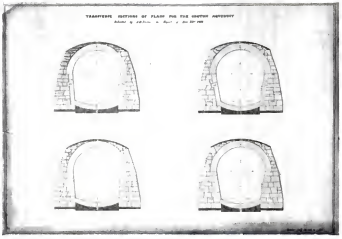
figure 12: Fayette B. Tower, **Croton Aqueduct at Haarlem River** (High Bridge), c.1842, ink with watercolor wash on paper
Courtesy Mrs. Helen Tower Wilson. Photo: T. Harnik

the Bronx River and the Croton River as a supply. Among the participating engineers was Major David Bates Douglass (figure 10). A veteran of the War of 1812 who had been cited for heroism during the defense of Fort Erie, Douglass emerged as the new champion of the Croton River as a water source. He suggested two possible routes to get Croton water to the City, one along the Hudson and one inland, and favored a masonry aqueduct tunnel. The cost for either route averaged about $4.5 million. In aligning solidly behind the Croton as a source, Douglass supported the findings of Colonel DeWitt Clinton, but ran contrary to the "Father of American Civil Engineering," Benjamin Wright. Although in opposition to the esteemed Wright, Douglass' plan put him in favor with a leader of the Croton faction on New York's Board of Aldermen, Myndert Van Schaick. Even though the Wright report, submitted early in 1834, supported the earlier recommendations of William Weston and Canvass White in favor of the Bronx River as a source, Van Schaick felt that Wright was in error in confining his investigation to the Bronx watershed. Van Schaick's support was integral to getting the Douglass proposal adopted by the Water Commissioners, as was the fact that the chair of the Commissioners, former New York Mayor Stephen Allen, was a proponent of the Croton. Douglass was selected to head the project, but not before another engineer, John Martineau, was hired to make another survey.

Chiefly brought in to try to reduce Douglass' cost figure, Martineau trimmed $1 million from the previous amount by moving the dam location close to the confluence of the Croton and Hudson Rivers, thereby shortening the length of the aqueduct, and by suggesting an alternative to Douglass' high bridge over the Harlem River. Instead, Martineau favored the use of wrought iron pipes in the form of inverted siphons to cross the river. The pipes could be placed on an embankment containing an arch to permit navigation of the river. Martineau felt the use of inverted siphons would eliminate the need for the high bridge to keep a uniform grade level for the aqueduct. Douglass, in recommending the more expensive open aqueduct bridge was following the advice of Colonel Clinton who also favored a 138-foot-high, 1,000-foot-long structure across the Harlem. John B. Jervis, the second chief engineer of the Croton Aqueduct would have the actual responsibility of designing and supervising the construction of the bridge across the Harlem River. As directed by an act of the State Legislature, whose goal was to protect navigation on the Harlem River, Jervis built the High Bridge largely to the Clinton-Douglass specifications, but also using Martineau's inverted siphon idea to allow for a somewhat lower and less expensive structure (figure 12). This still would adhere to the Legislature's height requirement. The huge stone structure was a major contributor to the enormous jump in the final cost of the Aqueduct to $9.5 million.

When Douglass took over as chief engineer of the Croton project in June 1835, his first task was to lead a survey party into Westchester County. Stephen Allen was less than impressed with what he regarded as an unnecessary delay, since Douglass already had made two previous examinations of the Aqueduct's line. Douglass further perturbed Allen by taking a year to furnish maps and then conducting a fourth survey. To do so Douglass asked for a larger staff. Allen vetoed the request because he sought to show progress as well as economy and it seemed to the Water Commissioners that Douglass was interested in neither. Finally, by September 1836, the surveys were complete, but lack of bid specifications resulted in additional delays. Douglass' excuses and continual requests for more staff resulted in the Water Commissioners asking for his resignation. Refusing to leave, the Commissioners fired him.

Douglass' removal brought to the chief engineer's position the man who supervised construction for nearly 13 years and was most responsible for the successful and timely completion of the "Old Croton," John B. Jervis (figure 11). The selection of Jervis to direct the building of the Croton Aqueduct was due largely to his experience with artificial waterways. Jervis had no formal education as an engineer, but worked his way up through the various jobs on a survey party, beginning with that of axeman. He started in 1817 and by 1825 had "graduated" from the civil engineering "school" of the Erie Canal and immediately thereafter accepted a position as Benjamin Wright's principal assistant on the Delaware and Hudson



Canal. Within 2 years he succeeded Wright as chief engineer. Upon completion of the Delaware and Hudson in 1830, Jervis digressed from canals long enough to build the first two railroads in New York State. Three years later he was back to canals, this time it was the Chenango between Utica and Binghamton, New York. Then in early 1836 Jervis was appointed to head the eastern division of the Erie Canal enlargement project. After only a few months on New York's principal waterway, he was lured to the Croton project by the prospect of engineering one of the nation's first major urban water systems.

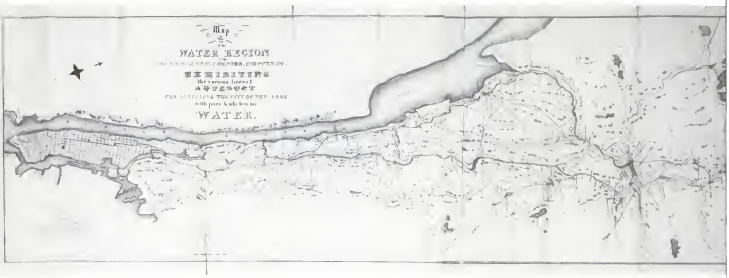
Jervis eagerly plunged into his new assignment in October 1836, within ten days of his taking the chief engineer's position. He began by examining the site of the proposed Croton Reservoir and the line of the water tunnel from the dam location to the Harlem River, as laid out by Major Douglass. Jervis opted for and approved of Douglass' route along the Hudson River since, as he noted, the line was "side-lying" with land along the line either much above it on one side or much below on the other (figure 13). No great variation would have been possible. Jervis also concurred with the location of the dam at Garretson's Mill, seven miles upstream from the Croton's junction with the Hudson. He felt that a high dam would create a large reservoir wherein a more complete deposit of sediment would occur. Yet, in his report to the Water Commissioners he expressed caution at placing high dams across rivers that were subject to heavy floods. The Commissioners ignored his concerns however, and a little more than 4 years later a January 1841 flood carried away a major portion of the dam with a loss of three lives. A replacement structure of novel construction and design was rapidly completed under Jervis' direction and remained in use for 64 years until superseded by a larger structure.

The Croton Dam, which created a 400-acre lake, was the first big masonry dam in the United States and, because of its design, was in the vanguard of modern hydraulic engineering (figures 2 & 15). But it was only one of the several structures planned for the Croton water system. Another was the nearly 40-mile-long tunnel needed to carry the Croton water from the Dam to the Distributing Reservoir on Murray Hill, between 5th and 6th Avenues, from 40th Street to 42nd Street (figure 16). Douglass proposed that the tunnel be constructed of stone with the top arched, the bottom an inverted arch, and the side walls tapering slightly inward toward the bottom. The brick- and stone-lined interior would be 7 feet 5 inches

figure 13, above: **Method of Construction on Steep Side Hills** [detail], c.1837-39, watercolor and ink on paper
Courtesy Jervis Public Library, drawing #199. Photo: G. R. Farley

figure 14, middle: **Transverse Sections of Plans for the Croton Aqueduct**, submitted by John B. Jervis in report of Dec. 23, 1836, ink and watercolor on paper
Courtesy Jervis Public Library, drawing #161. Photo: G. R. Farley

figure 15, below: Robert Havell, Jr., **View of Croton Dam**, engraved by Henry Jordan & Frederick Halpin, frontispiece from Charles King's *A Memoir of the Construction, Costs and Capacity of the Croton Aqueduct ...*, New York, 1843
The Hudson River Museum of Westchester, Gift of John Zukowsky. Photo: B. Sigler



wide and 8 feet 5½ inches high, at its greatest. Thirty-three ventilators were built at mile intervals to provide air circulation and tunnel access. Six waste weirs would allow for the exit of excess water and 114 stone culverts would carry the Aqueduct across the numerous small streams along the route. Jervis altered the Douglass plan only in the shape of the tunnel. He redesigned the vertical walls to make the space between them somewhat wider at the lower end than called for by Douglass. This would make the sidewalls 4 feet high instead of 4.2 feet and save a total of $500,000 along the entire length of the tunnel. It would also allow for a greater discharge of water than the original specifications.

In addition to its many culverts, four much larger structures were designed to cross large streams and wide depressions in the land. The plans called for an 88-foot-long bridge across the Sing Sing Kill, an iron pipeline laid atop an earthen embankment across the 4,180-foot-wide Manhattan Valley, a 1,900-foot-long masonry wall across the Clendenning Valley with archways to accommodate the streets planned for upper Manhattan and, of course, the magnificent Harlem River Aqueduct Bridge. Jervis' planning for the Sing Sing Bridge can serve as an example of how the chief engineer drew on prior knowledge and experience in deciding upon the design and material for the structure (figure 17).

In a report to the Water Commissioners dated February 8, 1837, the chief engineer cited both the High Falls Aqueduct on the Delaware and Hudson Canal and the Little Falls Aqueduct on the Erie Canal as examples of masonry waterway structures. Having worked on both canals he was familiar with the aqueducts and their durability. He noted that the 15-year-old Little Falls Aqueduct had suffered considerably from the frost even though it was laid in hydraulic cement. The ten-year-old High Falls structure fared better due to the draining of the canal water at the end of the navigation season. But Jervis considered all masonry aqueducts too prone to leakage to be acceptable for the Croton requirements. For a solution, Jervis turned to the work of English engineers, in particular the Chirk Aqueduct on the Ellesmere Canal and the Slateford Aqueduct on the Edinburgh and Glasgow Union Canal. In both structures,

figure 16, above: David B. Douglass, **Map of the Water Region/Counties of Westchester and Putnam/Exhibiting the various lines of Aqueduct for supplying the City of New York with Pure and Wholesome Water**, c.1835
Courtesy Jervis Public Library, (not in exhibition). Photo: G. R. Farley

figure 17, right: Fayette B. Tower, **Croton Aqueduct at Sing Sing Kill**, c.1842, ink on paper
Courtesy Helen Tower Wilson. Photo: T. Harnik

cast iron was used for the bottom and in one, for the sides of the water channel. Since the Chirk Aqueduct, for example, was still water-tight after 30 years of use, the design that Jervis recommended was an amalgam of the American and English works, a masonry structure with the waterway lined with cast iron.

In suggesting the design for the Sing Sing Aqueduct Bridge, Jervis revealed early in 1837 the approach he would take in planning the building of the other major structures of the Croton system. He informed the Water Commissioners that his object was to use a "plain and substantial style of architecture," and to avoid ornamentation except that necessary to the stability and longevity of the work. It is interesting to note that the chief engineer consid-

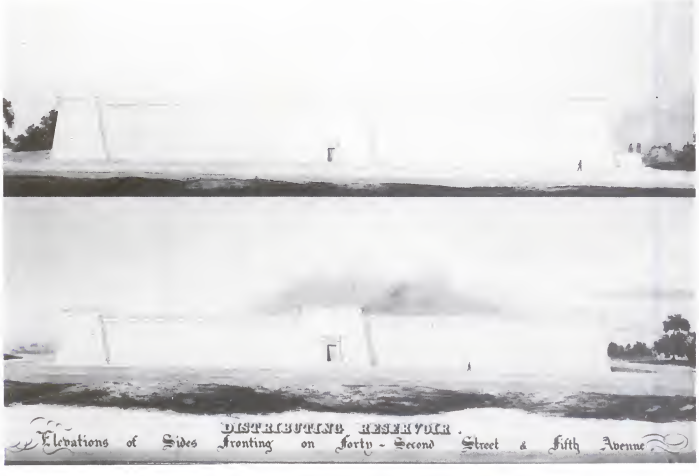


figure 18: James Renwick, Jr., **Distributing Reservoir**, watercolor in "Letter Book of J. B. Jervis"
Courtesy Jervis Public Library. Photo: G. R. Farley

ered some ornamentation necessary also to avoid the impression that insufficient attention had been given to certain important parts of the structure indicating a lack of "firmness and durability." The massive 20-million-gallon Distributing Reservoir was another example of Jervis' approach in simplicity of planning to relate design to function (figures 18 & 49). This huge stone masonry holding pond, the walls of which would average 45 feet above street level, was to be given a rather plain Egyptian style façade. Other engineers, including some among the Croton corps, might have built this reservoir in the much more elaborate European Gothic architectural style that was rapidly gaining popularity in the United States. After all, the Distributing Reservoir, among all the Croton structures, was the one that would be most in the public eye, due to its location.

In the preparation for and execution of such a large project with its diversity of structures, the organization and assignment of duties of the engineering corps was of utmost importance. Although the actual building work on the Croton project was done by independent contractors and as many as 5,000 laborers, the coordination and inspection of their work, as well as the running of the aqueduct line and the design of its structures, were among the responsibilities of the engineers. When the Croton project started in 1835, few examples of hierarchical organization to achieve efficient operation of such an immense undertaking existed in the United States. Large corporate enterprise with its pyramidal chain of command and substantial managerial bureaucracy did not exist. Neither did government on a grand scale. Even the U.S. Army, a body that logically should have functioned with a staff organization to ensure more efficient operation, remained small and simple in operational structure. The Civil War with its immense armies would begin to change this, but that remained more than a quarter century in the future from the beginning of the Croton works. In the case of the New York City Waterworks, it was the two chief engineers, David Bates Douglass and John B. Jervis, who systematically organized the engineer corps in order to accomplish the task of building the Aqueduct.

Major Douglass, first chief engineer of the Croton, graduated from Yale University during the War of 1812 and was commissioned a Second Lieutenant in the Army Corps of Engineers. After the war, he gained additional experience as a professor of engineering at the United States Military Academy at West Point and in work on several canal and railroad projects. Also, in 1825, Douglass briefly observed and made notes on the building of the Erie Canal, the greatest of American waterway accomplishments at that time. But, it took Douglass several months to structure the Croton Aqueduct engineering corps for efficient, effective management and building and to define systematically the duties and responsibilities of the Engineering Department, since apparently he was preoccupied with the surveys. It was not until the end of February 1836 that he drew up twelve "specifications" in "obedience" to a request from the Water Commissioners to define the tasks of the engineers and the organization of the department. Yet, when Douglass finally did rationalize the operation of the engineers, his plan was largely followed by his successor who directed the building of virtually the entire aqueduct. Douglass' definition of the duties and responsibilities of the Croton Engineering Department can serve as an example of how the project was organized and managed.

After stating initially that the Water Commissioners would have general administrative overview of the project as a "Board of Directors," Douglass divided ten of the remaining eleven "specifications" between the responsibilities of the Engineering Department and the particular duties of the chief engineer. According to Douglass, the Engineering Department would consist of the chief engineer and assistant engineers, rodmen (holders of the surveyor's target in order to assist in determining the necessary levels), axemen (persons who cut the brush from the line of survey) and inspectors (persons who inspected work done by contractors). The Department would administer the technical and professional duties related to construction. It also would prepare plans and designs and see to it that the contractors properly executed the work as per agreement. The Department would keep records of all correspondence, plans, and specifications of the project. The chief engineer was responsible

for the appointment of Engineering Department staff, the administration of the Department, and the disbursement of necessary funds, subject to periodic audit. He would act as "professional advisor" to the Water Commissioners with regard to the construction plans and the negotiation of agreements with the contractors.

Particular notice should be given to the emphasis on professionalism in Douglass organizational plan. At the time of the building of the Croton, American civil engineering was in the process of developing standards and rules of conduct so necessary to the formation and recognition of any profession. In the 1830s, the United States Military Academy at West Point, New York, and the Rensselaer School (later Rensselaer Polytechnic Institute) in Troy, New York, had the only two engineering programs in the United States. The widespread waterway and railroad construction ongoing then served in the training of civil engineers and, as was the case with the Croton, in the systematizing of their duties and responsibilities. It is interesting to note that while the Croton was under construction, its second chief engineer, John B. Jervis, participated in the initial attempt to create an American Society of Civil Engineers. In 1839 Jervis was among 17 prominent engineers, led by Benjamin Wright, who attempted to organize a society dedicated to the collection and distribution of "professional knowledge" and the advancement of the "character and standing" of American civil engineers. However, for a variety of reasons, their efforts ended in failure. Yet the attempt served to increase awareness of the necessity for professional standards and was the precursor of the current national engineering society of the same name, founded in 1852 and headquartered in New York City.

As soon as Jervis took charge of the Croton Aqueduct construction, he moved to revitalize the Engineering Department based upon his experience in state service on the Erie Canal and his high regard for professionalism. He began by enumerating items such as levels, compasses, chain tapes, and drawing materials that should be furnished by the engineers, then in rapid succession admonished a division resident engineer for not starting his party sufficiently early in the morning, and directed another resident engineer in the proper manner of operation of the engineer's office. Jervis' instructions were to have everything clean and orderly, to remove all unnecessary articles, and to allow "no smoking and no play of any kind." The office was to be "strictly a place of business."

For ease of management, Jervis retained the divisional breakdown of the aqueduct line that he inherited and even reappointed two of Douglass resident engineers. Each of the four 10-mile-long divisions were under the charge of a resident engineer. Each resident had one or two first assistant engineers and usually a single second assistant on his divisional staff. There were also inspectors, rodmen, and axemen, as needed. The resident engineers' pay was between $1,500 and $1,800 per year with the assistants earning from $720 to $1,000. Jervis' annual salary was $5,000 and that of Horatio Allen, his second in command, $3,500. By comparison, in an era when an urban family of four was estimated to have needed an annual income of at least $450 to subsist, the laborers who dug the ditch for the water tunnel were paid as little as 50¢ a day. During the winter months when most construction activities ceased, Jervis, ever mindful of economy, reduced the size of the staff in each division.

The organization of the Engineering Department that was used on the Croton Aqueduct served as a model and was carried over into many later projects by the engineers who furthered their professional training on this great water system.

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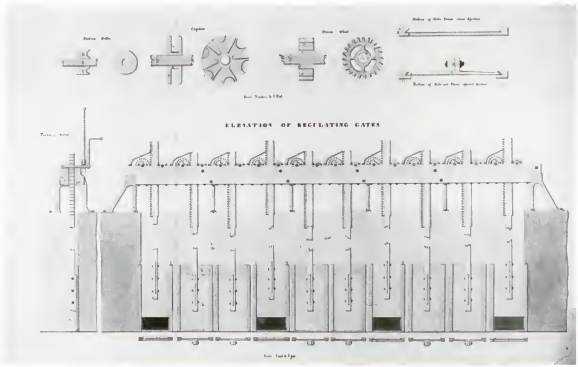


The Engineering Design and Hydraulic Concepts for the Croton Aqueduct

Emory Kemp

figure 19: Possibly by John B. Jervis, **Elevation of Regulating Gates at Croton Dam**, c.1841, watercolor and ink on paper
Courtesy Jervis Public Library, drawing #189 (different version in exhibition)
Photo: G. R. Farley

Introduction

Having resolved on the work, they carried it forward with a degree of constancy and energy alike remarkable, so that in the space of five years, an aqueduct was completed, which, for the natural difficulties overcome, the substantial character of its structures, the very remarkable verification, in the results, of the previous calculations of the engineers as to the flow of the waters, and the quantity that could be delivered, for the extent of its course, and the abundance of its supply, may be ranked among the foremost of like undertakings throughout the world.

Yet, with all this energy and perseverance, there was no rashness. The calculations of the cost, were carefully made, and it is a circumstance unparalleled probably in the history of like undertakings, and one which reflects great credit on the exactness of the knowledge of the chief engineer, Mr. Jervis, and on his professional skill and fidelity, that the very first estimate he gave, after he had made himself master of the details of the proposed work, and had the experience of some few contracts, has turned out to be within, and not much differing from, the actual cost.[1]

This statement appeared in Charles King's *A Memoir of the Construction ... of the Croton Aqueduct ...*, published around the time of its opening. Not only does King present details on the construction, cost, and operation of the new Aqueduct, but he places this great engineering work in the same category as the Roman aqueducts and compares it favorably with more modern European water supply schemes of his day.

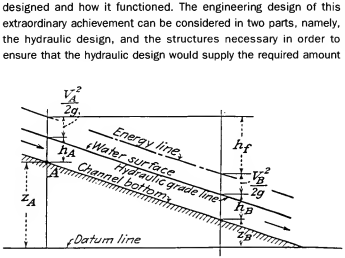
In many ways King's evaluation was correct. Excepting transportation works such as the Erie canal, the Croton Aqueduct was the greatest public work in antebellum America. It is little wonder that much has been written about this work from the time of its completion until our own day.[2] But there has been little in the wealth of published material to explain how the Aqueduct was designed and how it functioned. The engineering design of this extraordinary achievement can be considered in two parts, namely, the hydraulic design, and the structures necessary in order to ensure that the hydraulic design would supply the required amount of water to New York City. Before describing the salient engineering features of the Aqueduct from the Croton River to Manhattan Island, however, it is well to discuss the design methods employed for the Aqueduct.

Hydraulic design

Engineering design is a creative activity more nearly akin to art than to science, although in modern times, engineering has depended increasingly upon scientific knowledge to produce the most acceptable designs. As there is no unique solution in engineering design, the success of a particular engineering work can be measured as much on its form in relation to its function and the materials applied, as in questions of aesthetics, economics, scale, and utility. On these criteria the Croton Aqueduct provides an outstanding case study of the factors inherent in the design of any successful, large scale engineering work.

The first step was to determine the quantity of water to be delivered at the Croton Distributing Reservoir at 5th Avenue and 42nd Street in Manhattan. The system was designed for a population of 450,000 people using 20 gallons per day, which would give the requirement of 9 million gallons to be delivered by the Aqueduct. It is interesting to note that this appeared to be perfectly adequate in the minds of the designers who had no idea that the New York metropolitan area would exceed 10 million in population in our day and use perhaps five times as much water per capita.

After the engineers Canvass White and Major Douglass studied a number of potential water sources in the New York City area, it was decided to build a gravity system utilizing water from the Croton River more than 40 miles away. The advantage of using a gravity system is that it functions without employing any pumping machinery. The quantity delivered in the system is a function of the slope of the conduit, the roughness of the walls and bottom of the aqueduct, and the cross sectional area of the water in the channel. As early as 1735, Daniel Bernoulli, a member of the famous family of mathematicians, derived the basic equations of the flow in a gravity channel. From the equation and diagram (figure 20) it can



$$z_A + h_A + \frac{V_A^2}{2g} = z_B + h_B + \frac{V_B^2}{2g} + h_f$$

V = VELOCITY AT DESIGNATED POINT, feet/second

$\frac{V^2}{2g}$ = ENERGY HEAD, feet

h_f = HEAD LOSS, feet

g = gravity

figure 20: **Bernoulli's Equation for Open Channel Flow**

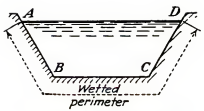
$V = C\sqrt{RS}$

V = MEAN VELOCITY OF FLOW

R = HYDRAULIC RADIUS

S = SLOPE OF THE AQUEDUCT

C = A MEASURE OF FLOW RESISTANCE CAUSED BY FRICTION ALONG THE SIDES & BOTTOM OF THE AQUEDUCT



Cross Section of Channel

R = HYDRAULIC RADIUS = $\frac{\text{area ABCD}}{\text{length ABCD}}$

be readily seen that the Bernoulli equation involves the elevations of various points along the channel, the height of the water flowing in the channel, and the velocity of the water. Later in the century, the French engineer and mathematician Chezy presented his well-known equation for determining the velocity of water in an open channel (figure 21). In the equation, the velocity is equal to a constant which is a function of the roughness of the conduit multiplied by the square root of the hydraulic radius and the slope. The hydraulic radius is the ratio of the cross-sectional area of water divided by the wetted perimeter. This relationship is shown in figure 22. Subsequent investigators derived similar formulas for determining the hydraulic radius and velocity in the conduit. After the completion of the Aqueduct, Jervis compared the measured flow to the design parameters based on formulas of Prony, Eytelwein and Robison. Baron Riche de Prony was a famous 18th-century hydraulic engineer and director-general of the Ecole Nationale des Ponts et Chaussées, and Johann Albert Eytelwein was a German army engineer who prepared a well-known book on hydraulic engineering published in 1801. It should be noted that Robison was an academic colleague of James Watt, the famous steam engine inventor and John Rennie, the British bridge builder. Robison's work was published early in the 19th century and was available to people like Jervis for design purposes.[3]

The quantity of water flowing in an open channel is the product of the cross section of the water and its velocity. Therefore, in order to provide the 9 million gallons per day, the engineer must establish an approximate cross section of the aqueduct, the roughness of the inside surface of the conduit, and the slope. To determine the grade line or slope and its most suitable location, it was essential to survey the entire route. The survey work was undertaken in 1833–34 on the Croton line under the direction of Major D. B. Douglass and he was joined in 1834 by John Martineau. It was Major Douglass who determined that a gravity aqueduct could be built from a dam on the Croton River to the north bank of the Harlem River at a constant slope of 13 3/4 inches per mile. Having set the slope, trial designs of various cross sections were evaluated so that the conduit selected would yield the quantity of water required. Jervis recorded Douglass' decision:

He [Douglass] *made the location of the line of the aqueduct from the Croton river to the north bank of the Harlem River 33 miles, and determined the grade of the aqueduct at about 13 1/4 inches to the mile. It was, in the main, well located.*

In regard to plans of work, he proposed a cross section of the masonry of the conduit with which some modification was adopted. So far as I have known, he prepared no specifications for the work that were approved by the commissioners.[4]

Jervis noted that Douglass did not proceed with the design of any of the structures for the Aqueduct.

Jervis described the cross section used and also provided an illustration (figure 14):

The form and dimensions of the interior of the aqueduct are as follows: The bottom is an inverted arch; the chord or span line is 6 feet and 9 inches, and the versed sine 9 inches. The masonry of the side walls rises 4 feet above the springing line of the inverted arch, with a bevel of 1 inch to a foot rise, or 4 inches on each side, which brings the

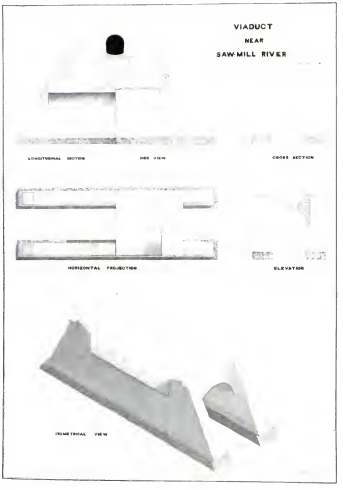
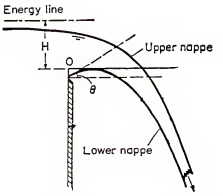


figure 21, above left: **Chezy's Equation for Flow Velocity**

figure 22, above right: **Hydraulic Radius for an Open Channel**

figure 23, right: T. E. Sickels, **Viaduct near Sawmill River**, c.1837, watercolor and ink on paper
Courtesy Jervis Public Library, drawing #245. Photo: G. R. Farley



width at the top of the side walls 7 feet and 5 inches; forming the abutments of the roofing arch, which is a semicircle, having a radius of 3 feet 8½ inches, or a chord line of 7 feet 5 inches. It will therefore be perceived, the greatest interior width is 7 feet 5 inches, and greatest height 8 feet 5½ inches. The area of the interior is 53.34 square feet. In rock tunnels the roofing arch is generally dispensed with, but the bottom and sides are formed with masonry similar to that above described. There is an exception to this form in the first 4.949 miles of the upper end of the aqueduct, where the side walls have an extra height, on account of the bottom being depressed, to draw the water at a lower level from the Croton Reservoir.[5]

In addition to this description and illustration, Jervis also provided a table delineating the masonry and piping which carried the water over the length of the Aqueduct:

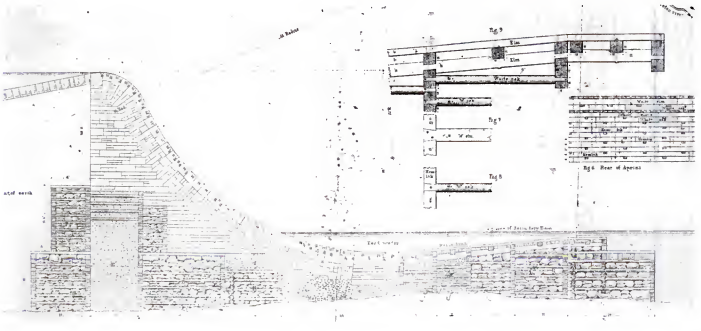
The length of aqueduct from the Croton dam to the distributing reservoir is 40.562 miles—to wit: [6]

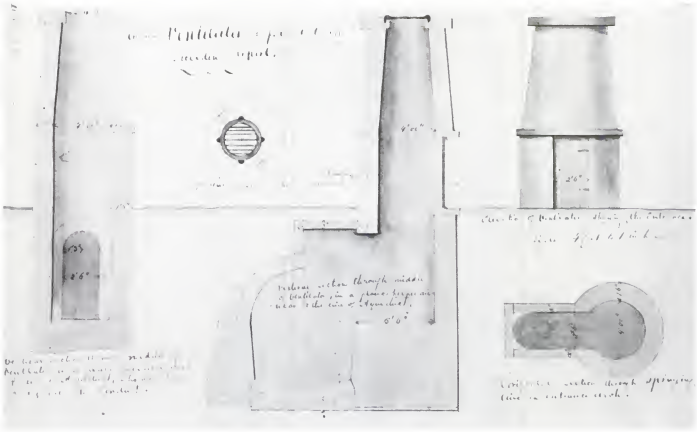
Masonry conduit in Westchester county	*32.880*
[Ditto ditto] *on New-York Island*	*4.187*
Total Length	*37.067*
Receiving reservoir from end of aqueduct to south-eastern effluent gate house	*0.172*
Distributing reservoir	*0.080*
Iron pipes on bridge over Harlem valley	*0.275*
[Ditto ditto] *across Manhattan valley*	*0.792*
[Ditto ditto] *between reservoirs*	*2.176*
	40.562

The various sections mentioned in the table are shown in figure 16. The route of the Aqueduct was over very rugged ground necessitating an irregular path in order to take advantage of the contour of the land. In order to maintain the constant slope of the Aqueduct from the Dam on the Croton River to the Harlem River, Jervis constructed a number of tunnels, culverts, embankments, and aqueduct bridges. In addition, ventilators were required to ensure that the water would flow under atmospheric pressure only and also to permit access so that the Aqueduct could be inspected all along its length.

Croton Aqueduct structures

Work began on the Aqueduct in 1837. One of the first tasks was to raise a dam on the Croton River to ensure a head of 40 feet above the river and to provide an intake for the Aqueduct. Work was well underway when a freshet struck the Croton River watershed. The dam was breached when the water rose 15 feet above the spillway of the dam. The masonry part was on solid rock and was not disturbed. Having inspected the damage, Jervis wrote to the Board to state the facts of the disaster. In many large public works this kind of disaster had resulted in the discharge of the chief engineer. That this did not happen to Jervis is probably due to his outstanding reputation, although he readily admitted that he did not anticipate such a flood in the 3 years that he had observed the hydrology of the area. It is fair to say in his defense that rainfall data was simply not available at the time. In designing a new dam with a much larger spillway capable of taking a larger quantity of flood water, Jervis was forced to build the Dam, in part, on a gravel bottom since the rock ledge did not extend across the river valley. Even though Jervis





designed what he called an artificial foundation, he was very concerned that the water over the spillway not scour the foot of the dam and ultimately lead to its destruction. He faced this new challenge with a very elegant solution that consisted of two parts. Rather than letting the water simply fall over the spillway, he designed a spillway to match the lower nape of the discharge (figure 24). This design made it possible to ease the water down the face of the Dam and discharge it horizontally onto an apron (figure 25). In addition, much energy could be dissipated in a back water pool. This Jervis provided by constructing a rock-timber cribbed dam of such a height to extend a back water to the foot of the Dam. It is believed that this is the first ogee shaped dam cross section used in America. Jervis reported that it worked well under both high and low flows over the spillway. There was little evidence of erosion of the stonework or of the apron during all of the years that the Dam functioned. When additional water was needed for New York, a second Croton Dam was built, which flooded Jervis' original. Although intact underwater, it no longer functions as designed.

Ventilators and tunnels

Since the Aqueduct was to be completely enclosed to protect it from the elements and from any possible contamination resulting from intrusion of surface waters, it was necessary to ensure that the inside of the Aqueduct was at atmospheric pressure. To this end, a series of ventilators were erected along the course of the Aqueduct (figure 26). A total of 33 ventilators were constructed, roughly one every mile in the upper portion of the Aqueduct. Of the total, only 11 of them had access doors for inspection purposes. Because the waste weirs provided ventilation, ventilators were not necessary in these locations.

When the line of the Aqueduct intersected a ridge it was necessary to construct a tunnel. There were 16 tunnels varying in length from 160 to 1,263 feet, giving a total length of 6,841 feet. In those situations in which the tunnel was excavated through sound rock, the roof of the Aqueduct was not lined. The walls and bottom, however, were constructed in the same manner as the rest of the Aqueduct, providing exactly the same flow characteristics throughout the length of the conduit to the north of the Harlem River.

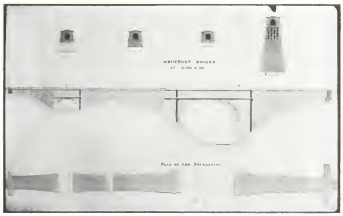
Embankments and culverts

In order to preclude any frost damage to the aqueduct masonry, Jervis preferred to use large embankments with the conduit buried

figure 24, above left: **Ogee Shape of the Weir Overflow**

figure 25, below left: Lt. Theophilus Schramke, **Croton Dam Design—Cross Section of Ogee Curve**, engraving in *Description of the New York Croton Aqueduct in English, German and French*, 1846
Courtesy William Lee Frost

figure 26, above: James Renwick, Jr., **Details of Ventilators**, watercolor and ink in "Letter Books of J. B. Jervis" (vol. III)
Courtesy Jervis Public Library, (not in exhibition)

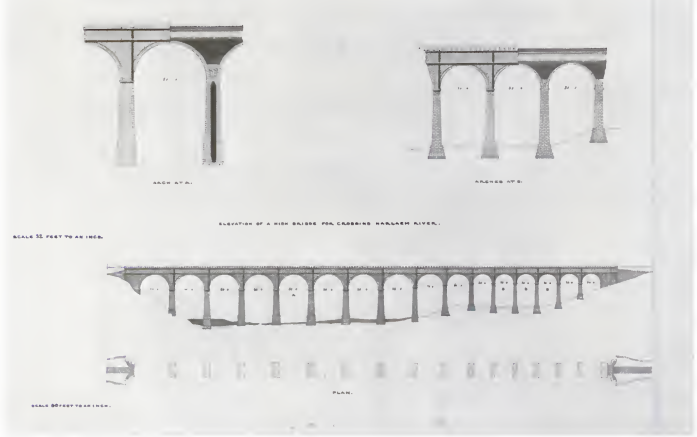


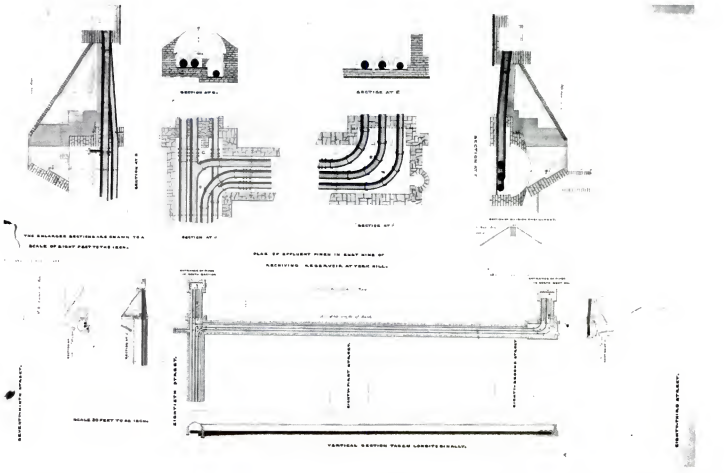
in the apex of the earthwork rather than resort to aqueduct bridges, which he feared might cause problems with frost action and attendant leakage. By using large embankments across the valleys, it was necessary to construct 114 culverts to allow water to pass from one side of the embankment to the other. These culverts varied from miniscule spans of $1\frac{1}{2}$ feet to 25 feet. The total length of all the culverts was 7,959 feet. Other notable structures in the form of culverts or small bridges were built at Mill River, Hastings, north of Tarrytown, and at Yonkers (figure 23). In addition to the culverts, six waste weirs were constructed to allow water to pass out of the Aqueduct when it rose above a certain control height. The flow out of the Aqueduct over the waste weirs was controlled by hand operated gates.

Aqueduct bridges

Where major water courses crossed the line of the Aqueduct it was necessary to build something larger than a culvert, and Jervis was forced to consider aqueduct bridges along the length of the Aqueduct between the Croton Dam and the north bank of the Harlem River. The most impressive of these aqueduct bridges was over Sing Sing Kill. It had a single span arch with a rise of 33 feet and a clear span of 88 feet (figure 27). The sophisticated design in which he used a five centered arch instead of a simple semi-circular span was a solid piece of work founded on rock, with the stone masonry laid out in hydraulic cement.

Jervis insisted on the use of hydraulic cement in all of the masonry work on the Aqueduct and its associated structures. Hydraulic cement differs from lime in that it will set under water and is water-proof, properties which Jervis felt were essential for the longevity of the Aqueduct. Jervis' concern for leakage and resulting damage in aqueduct bridge structures can be seen in the Sing Sing Bridge. Rather than having solid spandrel walls filled with earth, individual walls were carried out from the springing of the arch to a series of brick arches just below the line of the Aqueduct. Thus, any water leaking from the Aqueduct would pass into the void area and exit from the masonry work before it could do any damage. As further safeguard against leakage, Jervis, learning of the cast iron lining of the Chirk Aqueduct Bridge built by Telford in England, lined the Sing Sing Kill Bridge with cast iron plates.





The greatest natural obstruction to carrying the Aqueduct into Manhattan was crossing the Harlem River. There was much discussion of the most suitable way of effecting a crossing. An underground pipe passing under the river, designated by hydraulic engineers as an inverted siphon, was considered, together with a low level bridge carrying the water from the higher elevation of the Aqueduct in iron pipes across the river. There were concerns about the navigation of the river and doubts about a deep siphon because of Jervis' concern for leakage at the bottom, resulting from excessively high water pressure. After state legislation was passed requiring either a tunnel or a high-level bridge, Jervis convinced the water commission to build the High Bridge. A viaduct consisting of seven arches, each with an 50-foot span, and eight arches, each with an 80-foot span, was designed by Jervis to cross this river valley (figure 28). Since the level of the bridge was slightly below the grade line of the Aqueduct, Jervis designed twin wrought iron 30-inch diameter pipes to act as an inverted siphon, carrying the water for nearly 1,500 feet across the river at a height of 110 feet. In order to ensure an adequate flow of water, the grade line was dropped 2 feet from one end of the aqueduct bridge to the other. Considering the time of its construction, it was a work on a stupendous scale hitherto unknown in America. In contemplating High Bridge, Jervis was aware of and corresponded with the engineers responsible for, the construction of the aqueduct bridge across the Potomac on the Alexandria Canal. He was also aware of the aqueduct bridges built on the suspension system by John A. Roebling, the first at Pittsburgh and four more on the Delaware and Hudson Canal, on which Jervis was employed earlier as an engineer. High Bridge was a far more ambitious engineering achievement, however, comparing favorably with contemporary viaduct railway bridges constructed in Britain in both brick and stone and with classical Roman aqueducts. In fact, it is in a class with the Roquefavour Bridge Aqueduct, which was completed in 1846 in France. The grade line of the aqueduct supplying water to Marseilles was 270 feet above the valley floor and of comparable length to High Bridge. The Croton High Bridge is without peer in antebellum America and is the centerpiece of the Aqueduct.

figure 27, above left: Possibly by John B. Jervis, **Aqueduct Bridge at Sing Sing** (plan and elevation), c.1837-39, watercolor and ink on paper
Courtesy Jervis Public Library, Rome, NY, drawing #317. Photo: G. R. Farley

figure 28, below left: **Elevation of a High Bridge for Crossing Harlaem** [sic] **River**, c.1839-40, watercolor and ink on paper
Courtesy Jervis Public Library, Rome, NY, drawing #249. Photo: G. R. Farley

figure 29, above: **Plan of Effluent Pipes in East Side of Receiving Reservoir at York Hill**, c.1841, watercolor and ink on paper
Courtesy Jervis Public Library, Rome, NY, drawing #307. Photo: G. R. Farley

Inverted siphons

As indicated, it is possible to carry an aqueduct below the hydraulic grade line, which is the free surface of the water, diverting it into pipes which can descend into valleys and rise on the other side. At the lowest point, the water is under maximum pressure which, in effect, forces it up the other side of the inverted siphon and back into the open channel of the Aqueduct. In order to avoid major embankments or the use of viaduct bridges it was decided to cross Manhattan Valley with an inverted siphon containing a maximum center depth of 102 feet. Cast iron pipes, each 3 feet in diameter, were originally built and provision was made for two more if the water supplied to New York City had to be augmented in the future. In order to increase the flow through this inverted siphon, the elevation from the entrance to the exit was dropped 3 feet. This is 1 foot more than the decrease in elevation at the High Bridge.

In order to avoid the use of an inverted siphon to cross Clendenning Valley, a large earth embankment was constructed between 95th and 102nd Streets, approximately 1,900 feet in length with a depression at the center of approximately 50 feet. In order to provide access for streets, three archways or culverts were provided underneath the large embankments. The main archway has a span of 30 feet, whereas the two sidewalks had a reduced span of $10^1/_2$ feet. Cast iron plates were installed over each of the openings for the streets to preclude the entry of water into the masonry work.

From Clendenning Valley, the water was carried in a masonry channel to 85th Street and 7th Avenue, where it entered the first of two reservoirs. The Receiving Reservoir was constructed with a surface area of just over 35 acres. It was 1,826 feet long and 836 feet wide. It was divided into two basins so that any settling particles could be cleaned out of one of the basins without closing down the Aqueduct. The north division was designed for a depth of 20 feet, whereas the southern one was increased to a depth of 30 feet. As built, the Reservoir had a capacity of 150 million imperial gallons. From the Receiving Reservoir, the Aqueduct was carried in a series of iron pipes that conveyed water to the Distribution Reservoir located on Murray Hill, now the site of the New York Public Library (figure 29).

The Murray Hill Distribution Reservoir reflected the move in architecture during the late 1830s and into the 1840s to identify monumental engineering works with Egyptian revival details (figure 18). Such works were in contrast to Gothic revival structures identified with churches and educational institutions and Classical revival used for public buildings and such structures as banks.

In order to provide a sufficient head for distributing the water, it was necessary to build the walls of the Reservoir an average of just over 45 feet above the grades of the street. This would provide an elevation of 115 feet above mean tide. The Reservoir was two city blocks wide and had a capacity of 20 million imperial gallons. From this Reservoir pipes were carried to all parts of the City for the distribution of water for domestic, commercial, and institutional purposes.

By constructing a temporary low-level bridge, it was possible to lay iron pipes across the Harlem River Valley allowing the Aqueduct to be opened before the completion of the High Bridge. On July 4, 1842, the first water was received at the Murray Hill Reservoir amid great acclamation from the citizens of New York City. The High Bridge was not completed until 1848.

Notes

1. Charles King, *A Memoir of the Construction, Cost, and Capacity of the Croton Aqueduct* (New York, 1843), p.220.
2. See selected bibliography on the construction of the Croton Aqueduct, p.57 of this book.
3. John Robison, *A System of Mechanical Philosophy* (Edinburgh, 1804).
4. John B. Jervis, "Memoir presented October 18, 1876," *Transactions of the American Society of Civil Engineers*, vol.6, p.55.
5. John B. Jervis, *Description of the Croton Aqueduct from the Dam to the Distributing Reservoir* (New York, 1842), p.10.
6. *Ibid.*, p.7.

figure 30: **An Improved Map of the Hudson River, with the Post Roads between N. York and Albany**, published by Harper & Bros., drawn & engraved especially for the tourist, 1836, from unknown guidebook
Courtesy Briarcliff Manor-Scarborough Historical Society. Photo: J. Kennedy

Temperament, temperance and Tolerance

An Appraisal of Conflicts Over Land Values and Laborers Along the Line of the Croton Aqueduct

Tema Harnik

During the controversial years when the Croton Aqueduct was debated, planned, and actually built, the land required for the line was just beginning to be divided and valued—but was, as yet, hardly "developed." The new public work would bring pure and abundant water to the City. Though it was intended to serve New York City, the project would disrupt local lives and land, stirring distrust of both City motives and the strangers—immigrant laborers—who would be hired to carry out the plan. Local suspicion translated into open opposition which shaped and, at times, even disrupted the progress of work along the line of the Old Croton Aqueduct.

Rural Westchester, invested with the richness of natural resources, was a fertile avenue along which to convey pure water to New York City. Surveyor George W. Cartwright staked the area to bound the Croton Reservoir in 1835:

Beginning at a peeled ash sapling in the west boundary of Ricket's farm, thence staked … in buckwheat near a large walnut … near a shell bark Hickory in the field, [through] *Tompkin's potato field … in Widow Webber's orchard, on the east side of the turnpike near Flewelling's farm … on the west side of Hog Hill Road* [and] *obliquely up the valley,… staked in Hyatt's garden,… hence at a blazed apple tree on east side of turnpike near Ferris; … staked behind Taylor's shop on the corner of a woodhouse near the well… to a blazed post on a grape frame … and thence along the turnpike fence to station No. 6, north west corner of Purdy's House*[1] (figure 31).

But the land along the Croton and Hudson Rivers was occupied, and at first largely owned, by the tenant farming families who had purchased plots from the Commissioners of Forfeiture in 1785, following the American Revolution and the break-up of the manors. Odell, Hyatt, Wildey, Acker, Beekman, Van Cortlandt—the names of these Westchester landholders of the first quarter of the 19th century are familiar to us today from street names and neighborhoods in the towns of Greenburgh, Mount Pleasant, and Cortlandt.

Tenant farming families were not the only landowners along what was to become the Croton Aqueduct Trailway. Following the War of 1812, land speculators ransacked the county to exploit its valuable lands. Led by merchants and entrepreneurs from the City, this movement rumbled toward the impending development of the Hudson Valley—especially Westchester's river towns (figure 32).

Before 1850, however, profit in real estate speculation from the sale and re-sale of large parcels was much more important than the development of the property.[2] For example, Verplanck's Point (Croton), in the town of Cortlandt, had been owned jointly by Philip and William Verplanck. In 1836 Philip sold his portion on the river end of the point to a ten-man syndicate from New York City for $450,000.[3]

Still, in the years before the Aqueduct, large landowners had amassed substantial estates across the county and had begun to parcel out smaller plots to an incipient village middle class. Thus, in 1835, lots were advertised for sale in Beekmantown (today North Tarrytown). David B. Douglass, the Aqueduct's first chief engineer, appeared as a landowner along the line of the Aqueduct, near Indian Brook in Mount Pleasant (today Ossining); Oscar Irving and his uncle Washington Irving had their neighbor George Harvey re-model Sunnyside in Greenburgh during this year; at the same time Alexander Hamilton's son, Colonel James Hamilton III, established columned Nevis, slightly to the south (still visible today from the Aqueduct Trailway in Irvington). The Gothic-style site we know as Lyndhurst in Tarrytown was built in 1838 for former New York City Mayor William Paulding (figure 33).

In 1832 Van Brugh Livingston had village lots laid out with the intention of starting a town he called Livingston's Landing in what is today Dobbs Ferry. Stephen A. Halsey, who owned a parcel of

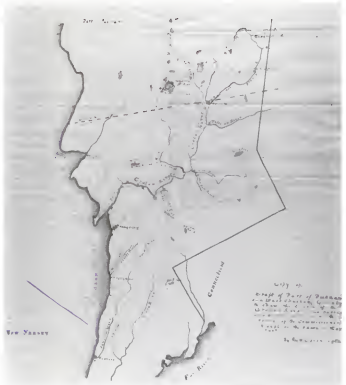


figure 31, left: George Cartwright, **Survey of the Croton**, 1833, ink on paper
Courtesy The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges

figure 32, above: **Croton Lake**, wood engraving in "From Croton to Town," *Harper's Magazine*, July 6, 1872
Courtesy Dobbs Ferry Historical Society (not in exhibition)
Photo: J. Kennedy

this land by 1837, received $4,000 from the Water Commissioners for the Aqueduct right-of-way there. By 1838 part of this property had been acquired by William V. Brady, future Mayor of New York.[4]

In 1834, Livingston sold a marble quarry in Hastings-on-Hudson and about 15 acres of land to George Harvey for $1,200[5] (figure 34). In the midst of the June 1838 Aqueduct construction there, Harvey sold 1.354 acres just west of the quarry to the City of New York for $2,500, reserving a right-of-way for his inclined railway leading to the river dock. The Aqueduct thus crossed the tracks on a bridge.

By the mid 1830s there were about 200 landowners on the line of the Aqueduct and Croton Reservoir who would have to be displaced or compensated. Chief Engineer David B. Douglass recognized the "anxious expectations of the community"[6] who were unsettled both physically and psychologically. These landowners would not be easily pleased.

According to law, the state had the right to claim private lands for public works. As Charles King noted in *A Memoir of the Construction, Cost and Capacity of the Croton Aqueduct* ..., there was ancient Roman precedent concerning the "taking of private property for public purposes, upon an estimate to be made by 'good men.'" He quotes Frontinus' ancient view:

... so admirable was the equity of our ancestors, that when on the line of an aqueduct, any owner of lands was unwilling to sell the portion required for the public work, the whole farm was bought by the State, and after taking what was requisite, the rest was resold. [7]

On May 2, 1834, meeting on this principal, the State Legislators passed an act providing for the acquisition of lands and the creation of the Croton Aqueduct. The Water Commissioners determined that the names of all holding land on the right of way should be ascertained and each resident visited in person by the engineering corps. Chief Engineer Douglass found, not surprisingly, that landowners had their own idea of the amount they should be compensated for their property.

Some of them are not at home when called on; others are a mile or two away from their residences; and many who are seen want time to make up their minds as to the amount of compensation they ought to receive .... This to be effected on a line of 30 odd miles, is not very easily accomplished.[8]

Douglass continued adjusting the line of the future Aqueduct. By November 24, 1835, Douglass wrote to Commissioner Allen from Yonkers of success:

I am happy to say that our location generally in the vicinity above this appears to give very general satisfaction. Mr. Oscar Irving, whose house we pass very near, expresses himself entirely satisfied. Mr. Hamilton [at Nevis] *likewise. Mr. Livingston* [at Dobbs' Ferry] *I did not see, but as I have endeavored to meet the interest of his property ... I trust he will be satisfied. Mr. Constant* [Hastings] *is much pleased with the present arrangements. J.W. Wells of this place* [Yonkers] *whom I met today, expresses the greatest cordiality and good feeling.*[9]

In general, Douglass boasted "that a better disposed or more reasonable set of landholders than those on the line of the Croton Aqueduct is very seldom found."[10]

Very soon after, however, the disposition of Westchester landholders worsened. Word spread that additional lands were needed along the line, and the belief spread with it that Westchester properties to be taken for the Aqueduct were being undervalued. Landholding farmers refused prices offered to them by the Water Commissioners, and lumbering court proceedings replaced on-site appraisals.

Douglass, who had been replaced as Chief Engineer on the project by the Water Commissioners because of political differences, bitterly complained of the management approach taken by the City in the matter of land taking:

Had a proper, businesslike agent been sent up with me as I requested in the month of March 1836, with full powers—there can be no doubt that amicable arrangements would have been made with a large proportion of the proprietors upon the most equitable terms.

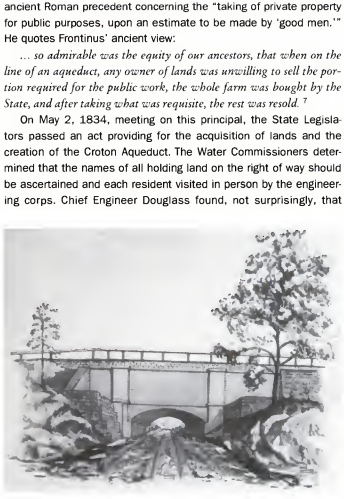


figure 33, above: David B. Douglass, **Land Takings Map #46: Lands of Livingston and Haisey (including Zion Church, Dobbs Ferry)**, 1836, ink and watercolor on paper
Courtesy Westchester County Archives, Andrew J. Spano, County Clerk
Photo: J. Kennedy

figure 34, left: Fayette B. Tower, **Over Railroad to Mr. Harvey's Marble Quarry, Hastings**, c.1842, ink with watercolor wash on paper
Courtesy Mrs. Helen Tower Wilson. Photo: T. Harnik

Instead of this, the Board waited till July and August [1836], *with a full knowledge that the people were becoming every day more and more exasperated, and then rode through the country, calling the farmers from their work in the fields to the side of the carriage to be brow beaten and overborne.*

If the object of the commissioners had been to create precisely the greatest amount of hostility to their purposes, they could not have adopted more effectually, means for its accomplishment.[11]

Convinced that the 1834 enabling legislation did not protect their rights, a group of Westchester landholders conducted a very strong demonstration against the act at the 1836 legislative session. The identities of all protesting property holders remain elusive, but they appear to have been the more wealthy landholders. Moreover, their outspoken opposition to the plans coincided with their assumption of positions of responsibility in local government in the period following the completion of the Aqueduct. The following Aqueduct property owners, for example, were soon office holders:

James Acker	(Greenburgh Supervisor, 1843)
Benson Ferris	(Greenburgh Supervisor, 1844; Town Justice 1845)
Isaac Coutant	(Mt. Pleasant member, County Board of Supervisors 1845)
Joseph Hunt	(Ossining member, County Board of Supervisors, 1845)
S. Swartout	(Greenburgh Town Justice, 1845; Town Clerk 1847)
P. K. Hart	(Greenburgh Town Justice, 1845, 1849)
Pierre Wildey	(Greenburgh Supervisor 1847, 1849)
Nathaniel Hyatt	(Greenburgh Constable, 1847, 1849)
Jacob Odell	(Greenburgh Supervisor 1850–1852)

If New York City citizens were going to get water for themselves out of this disruption, then these rural landowners felt they deserved greater compensation. Moreover, they proposed that whenever possible, "*first, legal possession and use of the land should remain with the original owners ...; second, that if the land was not used for the aqueduct, after being paid for, it should revert back to those from whom it was obtained; third, that provision should be made to prevent trespasses on the property of the inhabitants; fourth, that the persons through whose land the aqueduct passed should have the right to use the water, by allowing reasonable compensation for it; and fifth, that the Judges of the County Courts should act as appraisers instead of Commissioners appointed by the Vice-Chancellor.*"[12]

To move the enormous stalled work forward and divert local public attention away from controversial land evaluation, the Water Commissioners replaced Major David B. Douglass in October 1836 with John B. Jervis. Controversy would now focus on methods of construction and competition for contracting bids; a formal Commission of Appraisement was established in August 1836 to estimate the value of private Westchester lands taken for New York City's Aqueduct.

But problems with Westchester landowners continued. What the Water Commissioners characterized as "unreasonable demands ... by a portion of the inhabitants of Westchester" stymied the project. By law, engineers could not begin work on any lands not purchased or appraised. Anxious to get the work started and win support of the property owners along the line, that summer the Water Commissioners named as Commissioners of Appraisement three highly regarded Westchester men: William Jay of Bedford, Abraham Miller of North Castle, and William Nelson of Peekskill. In the fall Miller and Nelson began work, traversing the county and appraising lands in the path of the projected Aqueduct, from Dobbs Ferry south to the Harlem River.[13] Appraisals continued into 1838, with the appointment of John Targee, Samuel Gilford, and John L. Ireland as appraisers. Acting in a routine fashion, their surveys created little discord.

Some appraisals, however, met with outright opposition. For instance, in June 1837, Jervis' monthly report to the Water Commission recounted widespread complaints from landowners near Dobbs Ferry, requiring they "suspend [work] for the present."[14] Similarly, Jervis' brother William (a resident assistant engineer) wrote to him

from Yonkers of legal complications and local action:

I went up the line on Saturday for the purpose of getting a strip of land for temporary road—Dyckman seemed disposed .... Shonnard is to give me an answer this evening—he intends, however, making a condition that the contractor shall not build shanties on his ground ....[15] The landholders whose land has been taken possession of, according to Mr. Dusenberry's directions have, as was anticipated, had recourse to law to protect themselves. I understand that they have been advised to wait until damage to the amount of $50 has been done, and then bring a suit against the water commissioners[16] (figure 35).

Old Mr. Dearman is the only one who attempted to stop the men by force, but finding that he was likely to get the worse of it, he desisted from the attempt. Mr. Dusenberry having left me no directions how to proceed in case any of the men were taken—for trespass, I went up to Sing Sing on the Monday after and communicated what had occurred to General Ward. The General promised to take the necessary measures for releasing the men, if arrested, by promising bail. There has been, however, no necessity as yet for his interference[17]

The City Water Commissioners and County Appraisers were an official, removed target for Westchester residents; the immigrant laborers contracted to build the Aqueduct, whose shanties leaned up against local lands, were a much more immediate presence. A financial panic in the country, in 1837, raised the general level of disquiet. Though no violence seems to have erupted on the occasion of Mr. Dearman's protest, heated conflict among landholders, contractors, and laborers became difficult to quench during the 1837–38 construction season.

Economic depression in Ireland had offered nothing to keep Irishmen at home, and during the 1830s large numbers of Irish arrived in America. Mostly Catholics from the southern and western provinces, by 1836 almost 60% of New York's immigrant Irish were laborers or servants.[18] Large scale public works projects of the early 19th century provided relatively steady paid employment to these immigrants (figures 36 & 37). But if foreign, immigrant, single, Irish (and Catholic) laborers were admired by the engineers for their skilled mechanical abilities, they were especially suspect to the more modest Westchester farmers, struggling to establish themselves.

New York's Protestant urban society offered nothing familiar to ease their assimilation.[19] Arriving to work on public works projects, they encountered stereotypes of the Irish as hooligans, alcoholics, and even thieves. Rather than understanding the reality of poverty and homesickness in this strange new place and the meager working conditions along the line, Americans in early 19th century Westchester swallowed whole, as it were, this pre-digested image of the Irish laborer. Occasionally, some day laborers who were barely paid a subsistence wage, in fact fueled the farmers' stereotype-driven intolerance. Gabriel Purdy and Robert Tompkins, for example, complained of damage and petty theft by Aqueduct workers to farm lands along the line of the Aqueduct:

One of them had a few rails, and some small wood ... taken; another a small quantity of green corn and another, a quantity of apples; but whether these articles were taken by the laborers or not they cannot state. They all agree ... that they have never lost any potatoes or grain of any kind out of their fields, since the aqueduct has been building.[20]

The xenophobia and anti-Catholic biases of such influential Hudson Valley writers (and landowners) as Washington Irving and Samuel F.B. Morse did far more to excite popular prejudice. Morse, who published an anti-Catholic treatise on "Foreign Conspiracy Against the Liberties of the United States" in the *New York Observer* of 1834, linked Catholic enterprise with propaganda for monarchy.[21]

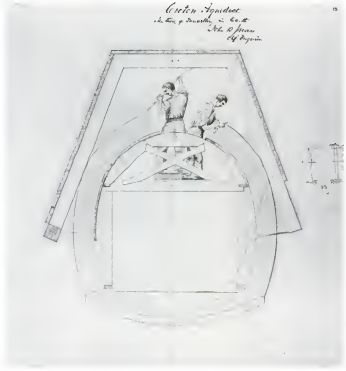


figure 35, above: David B. Douglass, **Land Takings Map #41: Land of Justice Dearman, Jewell and Stephen Tompkins**, 1836. Ink and watercolor on paper
Courtesy Westchester County Archives, Andrew J. Spano, County Clerk
Photo: J. Kennedy

figure 36, right: Lt. Theophilus Schramke, **Croton Aqueduct. Method of Tunneling In Earth**, c.1837–46, ink and watercolor on paper
Courtesy ESL Information Services, Engineering Societies' Library
Photo: J. Kennedy

figure 37: **Irish Ribbonmen**, wood engraving in *Harper's Weekly*, January 1, 1859
Courtesy The Historical Society of the Tarrytowns. Photo: J. Kennedy

Local farmers reading their words feared for their lands, animals, and what little goods they had accumulated.

Washington Irving also reflected and legitimized this popular anti-Irish prejudice. As he wrote to an acquaintance:

We have nothing new in these parts except that there has been the devil to pay of late in Sleepy Hollow; a circumstance by the bye, with which you of New York have some concern, as it is connected with your Croton Aqueduct. This work traverses a thick wood about the lower part of the Hollow, not far from the old Dutch haunted Church, and in the heart of the wood an immense culvert or stone arch is thrown across the wizard stream of the Pocantico [at Mill River Culvert] *to support the Aqueduct. As the arch is unfinished, a colony of Patlanders have been encamped about this place all winter, forming a kind of Patsylvania in the midst of a 'wilderness'* (figure 38).

A waggon [sic] *road cut through the woods and leading from their encampment past the haunted church and so one to certain whisky establishments, has been especially beset by foul fiends, and the worthy patlanders on their way home at night have beheld misshapen monsters whisking about their paths, sometimes resembling men, sometimes hogs, sometimes horses, but invariably without heads; which shows that they must be lineal descendants from the old goblin of the Hollow .... The whole wood had become such a scene of spuking* [sic] *and diablerie, that the paddys will not any longer venture out of their shantys at night and a whisky shop in a neighboring village, where they used to hold their evening gatherings, has been obliged to shut up for want of custom .... The Corporation of your city should look to it, for if this harrying continues, I should not be surprised if the Paddies, tired of being cut off from their whisky, should entirely abandon the goblin regions of Sleepy Hollow, and the completion of the Croton Water Works be seriously retarded.*[22]

Irving's account reflected contemporary Protestant demands for temperance, which tended to stigmatize the Irish and seek to discipline their behavior.[23] In a disciplinary, temperant spirit, New York's Water Commissioners had forbidden the operation of whiskey shops within a mile of the line.

The contractors promise ... that they will not ... give or sell any ardent spirits to their workmen, or any person at or near the line of the aqueduct ... and will do all in their power to discountenance its use in the vicinity of the work ....[24]

"As yet," said the Commissioners in June 1837, "no complaints have been made and the Commissioners entertain the hope, that the evils anticipated by some worthy citizens of Westchester, will not be realized." But, not surprisingly, grog found its way into neighboring farm houses anyway, and the inevitable disorder followed. During a drunken brawl in April 1838, a fight occurred among the laborers in which one man was killed and several were injured. Displaying typical anti-Irish bias, West Point-trained resident engineer Edmund French wrote to Jervis from Sing Sing, April 25, 1838,

"The affair that resulted in the death of one of the overseers on Section 10 appears to have been nothing more than one of the usual Irish fighting frolics."[25]

But if temperance and nativism colored the views of Westchester landowners, and the engineers and contractors were ruled by economic consciences, then the day-to-day realities of poor pay and shanty living drove the laborers' response. A drink or two to ease the day's burden might be one answer; labor protest was another. Aqueduct workers held strikes for higher pay in April and July of 1838:

The turn-out of the laborers ... commenced on section 15, under contract to Timothy N. Ferrell. The per diem pay, during the winter months, was 68½–75 cents; and the contractor posted a notice, that the pay for the month of April would be from 75–81¼ cents. The demands of the men, however, was 87½–100 cents per day ....[26]

The contractor refused the raise in pay, causing the laborers to quit in a body, and march in a "tumultuous manner" from the Croton Dam to Sing Sing, compelling those who were willing to work to join them, until they amounted to a crowd of several hundred. By April 10, Engineer Assistant Horatio Allen wrote a letter to Jervis from Sing Sing, assuring the Chief that:

All disturbance among the laborers has ceased, but very few more are at work than when you passed through the line .... The object is, I believe, to make the men feel the want of work, and then to re-employ them. I think it would be well to let it be known that men are in demand.[27]

A strike in April 1840 again expressed laborers' discontent with wage levels. Philip Hone, who would be appointed a member of the 1848 Board of Water Commissioners, wrote in his diary:

There has been a flare-up amongst the Irish laborers on the Croton Aqueduct occasioned by the contractors reducing their wages from $1 to 75 cents/day. Large numbers turned out and marched from Westchester to Harlem, prevented others from working, and committed some acts of violence upon the workers.[28]

The laborers' demands only confirmed nativist pre-conceptions about their unruly behavior. Moreover, the engineering corps and contractors, ruled by market logic, remained firm in the wage reduction. So New York Mayor Isaac Varian viewed the crowd protest as a "mob" and called in the militia.

The building of the Aqueduct brought protest—both by landowners through whose property the great public works project would course, and by the laborers who dug the tunnels and cemented the siphons which would carry rural water resources to the City of New York. Not surprisingly, those with less economic and political power fared worse. The laborers lost their strikes. They did, however, gain a foothold in the county.

In Westchester, intolerance of the intemperant immigrant laborers faded, albeit slowly. Irish workers soon settled in the communities through which they had labored, convening for Catholic masses on river piers and in private houses in Yonkers, Dobbs Ferry, Beekmantown, Sing Sing and Verplanck, and establishing the county's first Catholic parishes by 1850.[29]

Early plans for the Aqueduct (1835), set forth by the City's Committee on Fire and Water, had projected that "the cost of the work will consist almost entirely of labor: even the value of the materials ... used will consist in the labor bestowed upon them. And the whole of the labor and the materials will be furnished by the two counties of New-York and Westchester." The committee forecast large sums of money would be spent weekly in pay to several thousands of citizens, and the money would "regularly return to the city, to reward the industry of other classes of our citizens at home, giving energy to enterprise and vigour to exertion."[30]

No violence seems to have come of the landowners' protests, perhaps because their material goals had been achieved. The outcome was foretold in an article in the *New York Sun*, June 16, 1837:

Being mainly speculators themselves, the Commissioners must have known that landholders are seldom diffident in taking advantages of public improvements, to enhance the price of property.

As the Water Commissioners finally explained:

The cost of the land required was twice or three times what the owners estimated it at for farming purposes, the water and mill privileges, laying useless since the construction of the Erie Canal, all at

figure 38: **Bridge at Sleepy Hollow**, wood engraving in "From Croton to Town," *Harper's Magazine*, July 6, 1872
Courtesy Dobbs Ferry Historical Society, (not in exhibition)
Photo: J. Kennedy

once, when required for the aqueduct, became of great and intrinsic value in the estimation of the owners and their neighbors ....[31]

Eventually, the City paid $165,786 for 813 acres of rural Westchester land. Although modest in comparison to the $9 million construction cost of the Aqueduct, the conflict created during the evaluation of some 30 miles of land was substantial; the process repositioned and alerted Westchester's people at the dawn of suburban development along the Hudson River.

Notes

1. "Description of outer bounds or property line to be followed in making the survey of lands for the New York City Reservoir in Croton River," from survey by George W. Cartwright, David Bates Douglass Papers, The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges Geneva, NY.

2. Ernest F. Griffen, *Westchester County and its People. A Record*, vol. I (New York: Lewis Historical Publishing Co., 1946), p.320.

3. Frank Sanchis, *American Architecture, Westchester County, New York, Colonial to Contemporary* (New York: North River Press, 1977), p.64.

4. Document No. 14, June 30, 1837, J. B. Jervis' Monthly Report to the Board of Water Commissioners, p.112 accounts for the $4000 payment to Halsey. The passage of property in Dobbs Ferry from Livingston to Halsey and Stephen Archer is found in the *Abstract of the Title to the property "Ingleside"*; In 1845 Brady purchased another 4 acres of Dobbs Ferry land, just west of the Aqueduct and literally around the corner from the newly built Croton Aqueduct Overseer's House on Walnut (then Water) Street. Brady was elected Mayor of New York City in 1847. Brady's purchases are outlined in the *Title to property at 63 Livingston Avenue*. Archives, Dobbs Ferry Historical Society, Dobbs Ferry.

5. Mary Allison, "Hastings' White Marble Quarry: Its Rise and Fall," *Hastings Historical Society Newsletter*, May 1985. Harvey leased the quarry in April of 1835 to Elisha Bloomer, a New York City hatter and contractor, for $250 per year, and Bloomer built the inclined railroad that led from the quarry to the dock on the Hudson, visible in Fayette Tower's illustration **Over the Railroad to Harvey's Quarry**.

6. David B. Douglass, letter to the *New York Times*, October 30, 1840.

7. *Treatise on Roman Aqueducts*, p.207.

8. Douglass' Report to the Water Commissioners, January, 1836.

9. Letter from D. B. Douglass to Commissioner Stephen Allen, from Yonkers, November 24, 1835. John B. Jervis Papers, The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges, Geneva, NY

10. Douglass letter to *NY Times and Evening Post*, Oct. 30, 1840.

11. Ibid.

12. *Document No. 12, Report of the Water Commissioners to the New York City Common Council*, August 1, 1836. p.65.

13. Commissioners' characterization of "unreasonable demands by inhabitants of Westchester" in *Document No. 24, Semi-Annual Report of the Water Commissioners*, January 1837, p.99; *Document No. 24, Semi-Annual Report to the Board of Aldermen*, August 1, 1836, states: "The appraisers met at the house of S.M. Tompkins in the Village of Sing Sing at 12 o'clock on the 2nd day of August...and completed their estimate and appraisal on the 3rd day of August...."

In *Document No. 55, Semi-Annual Report for July–December 1837*, Jan., 1838, "commencing that owned by Jasper Stymets and extending about 16 miles south to the land purchased by William Beach Lawrence Esq., bound by the Harlem River, which includes all the land required for the Aqueduct in the county of Westchester, not previously purchased. The meeting of the appraisers was ... fixed and notified for the 23rd of Oct. 1837, at the house of John Bashford, in the village of Yonkers."

14. J. B. Jervis' monthly report to the Water Commissioners, Document No. 14, June 30, 1837, p.112

15. Letter to John B. Jervis from his brother William, Yonkers, April 16, 1838, John B. Jervis Papers, Box #23, Jervis Public Library, Rome, NY.

16. Letter to J. B. Jervis from H. T. Anthony, Tarrytown, February 29, 1838, John B. Jervis Papers, Jervis Public Library, Rome, NY.

17. Letter to J.B. Jervis from H.T. Anthony, Tarrytown, February 20, 1838. John B. Jervis Papers, Jervis Public Library, Rome, NY.

18. Kerby A. Miller, *Emigrants and Exiles: Ireland and the Irish Exodus to North America* (New York, Oxford University Press, 1985), p.238.

19. Nye, *Society and Culture in America*, p.205.

20. *Document No. 55, Semi-Annual Report of the Water Commissioners, July 1–December 30*, 1837, Jan. 1838, p.355.

21. Carl Russell Fish, *Rise of the Common Man, 1830–50*, p.113.

22. Letter to Lewis G. Clark from Washington Irving, Greenburgh, March 17, 1840. Library, Historic Hudson Valley, Tarrytown.

23. *Greenburgh Register*, Vol IX, no. 46, May 17, 1889 "Looking Back." The first annual report of the *Westchester County Temperance Society* showed that the Mt. Pleasant and Greenburgh Society, formed September 1829, had 146 members with Van Brugh Livingston, President, and Oscar Irving, Secretary. Livingston was active in the founding of Greenburgh's (South) Presbyterian Church in 1825, but by 1833 his strong devotion to the idea of temperance led him to withdraw from its communion over the issue of a tavern-keeper being elected Deacon of the church. Instead, he joined with neighbors Washington Irving and James A. Hamilton among others, and organized Zion Episcopal Church. Zion church was standing by 1834, where it stands today, near the corner of Cedar and Main Streets in Dobbs Ferry, literally adjacent to the Old Croton Aqueduct. Irving and Hamilton, as well as Van Brugh Livingston, were landholders whose properties were "taken" by appraisal, for the Aqueduct.

In a disciplinary temperament parallel to that of the Temperance leaders, a rather severe Chief Engineer Douglass acted the disciplinarian with his engineering corps of surveyors and rodmen, by forbidding them to play cards in their quarters in the evenings. Several quit the works, rather than be molded to Douglass' demanding code.

24. *Document No. 14, Semi-Annual Report of the Water Commissioners, January–June, 1837*, p.95.

25. Letter to J.B. Jervis from E. French, Sing Sing, April 25, 1838. John B. Jervis Papers, Jervis Public Library, Rome, NY.

26. *Document No. 3, Semi-Annual Report of the Water Commissioners, January–June 30, 1838*, p.57.

27. Letter to J. B. Jervis from Horatio Allen, Sing Sing, April 10, 1838, John B. Jervis Papers, Jervis Public Library, Rome, NY.

28. Hone, April, 1840, *The Diary of Philip Hone, 1828–1851*, ed. Allan Nevins, NY 1936).

29. Dobbs Ferry's first Catholic family—Joseph Lawlor and his father—are thought to have participated in the first mass read in the village, in a lime shed on Gould's pier on the Hudson. In 1847-48 mass was read "once every two months in Mr. Lawlor's house," according to the "History of the Parish of the Sacred Heart, Dobbs Ferry, NY and Local Facts Prior to Formation of This Parish; 1837-1933," archives/pamphlet collection, Dobbs Ferry Historical Society. Father Ryan said his first Yonkers mass in September, 1847; in 1850 he established a mission in Beekmantown, "where he offered the first mass in the Cedar St. home of Patrick Fitzpatrick." (Buxton, *History of the Tarrytowns*, p.252) St. Augustine's Roman Catholic Church was organized in 1850 to serve the Irish Catholic community in Sing Sing.

30. *Document No. 45, Report of the Committee on Fire and Water*, March 4, 1835.

31. *Document No. 12, Semi-Annual Report of the Water Commissioners for January–June, 1843*, July 8, 1843.

The Croton Aqueduct and Suburbanization of Westchester

Roger Panetta

figure 39: **The Aqueduct and Surrounding Neighborhoods, Yonkers**, c.1890s, contemporary print from original glass plate negative
The Hudson River Museum of Westchester

The building of the Croton Aqueduct is usually incorporated into the history of New York City where it is treated as a benchmark in the growth of the City's population or a chapter in the development of municipal services. The design and construction of the Aqueduct is also noted as one of the remarkable technical accomplishments of 19th-century engineering. The Croton Aqueduct is usually thus described as an example of an innovative technology and as a response to the needs of an expanding urban population.[1]

This urban-centered view of the history of the Aqueduct has neglected its impact on Westchester County. The construction of the Croton Aqueduct, independent of the service it provided New York, was a turning point in the history of Westchester County in the 19th-century; in conjunction with the railroad, it radically transformed Westchester's relationship with New York City. The decade of the 1840s, bracketed by the collapse of the first Croton Dam in 1841 and the completion of the Hudson River Railroad in 1851, fixed the suburban nature of the County and solidified the urban–rural nexus of New York and Westchester.

The history of the building of Croton Aqueduct reminds us of the value of water, one of the most important rural resources in the 19th century, and the ways it had become an invaluable commodity for urban populations and allied commercial interests. The premium attached to this rural resource was so high that cities and state legislatures were prepared to use their political power and commit their financial resources to overcome the reticence about public improvement schemes and get control of available water supplies. In the building of the Aqueduct, Westchester residents had to articulate and defend their interests in the ensuing battle with a city in desperate need of water.[2]

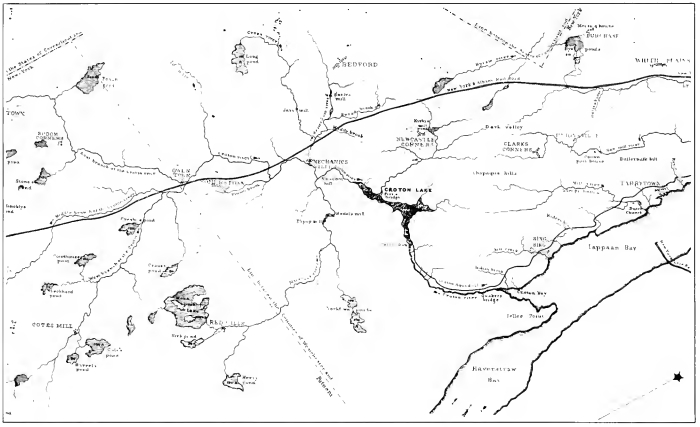
In July 1798 Dr. Joseph Browne, an engineer, first proposed that New York City go beyond its political boundaries for its water supply.[3] The Collect Pond, which along with the old Colles Wells, was the principal source of the City's water, Browne declared to be "a large stagnant, filthy pond," far too small for New York's needs. He proposed turning to the Bronx River as a new source, damming the River at West Farms and constructing a canal and tunnel to carry the water into Morrisiana Creek and across the Harlem River.

Several alternate schemes were advanced by others who saw the opportunities to profit from New York's desperate need for water if they could get a charter from the City. In 1821 the New York Sharon Canal Company proposed to use the Housatanic River in Connecticut as part of a canal scheme which would connect Sharon, Connecticut, with the Hudson River and could double as a water supply canal for New York City.[4] Indeed the successful development of transportation canals provided the conceptual precedent for the thinking about aqueducts and urban water systems.[5] The Sharon Canal project got nowhere.

In 1824 Canvass White, one of the engineers on the Erie Canal, presented a plan to the Common Council for tapping the Bronx River, which he described as an adequate source for the City. Again little was done. Finally in 1830 the first proposal for the use of the Croton watershed was made by Francis B. Phelps.[6] But like most of the earlier proposals this plan got bogged down in the City Council.

New York paid a high price for its failure to act; between 1829 and 1832 fires and cholera took lives and cost money. The cholera of 1832 was attributed to the City's reliance on well water.[7] These catastrophes made it difficult for politicians to avoid the issue any longer. Colonel De Witt Clinton, Jr., a civil engineer and the son of Governor De Witt Clinton, expressed this sense of urgency when he reported to the Fire and Water Committee of the Common Council in December 1832 his surprise and regret that "there should exist any hesitation to grant her power to obtain an element so essentially connected with the ... health ... of her citizens."[8]

But Clinton saw this not only as a health issue but one of "prosperity and comfort," as well. He criticized the State's legislative procrastination in empowering the City. Nothing, he argued, should stand in the way of New York's pre-eminence if the City was to "be to this country what London was to England."[9] Pre-eminence had dire implications for the neighboring regions. The rural community or region which is the source of this precious natural resource will not only find itself under severe pressure to yield but will face a future in which a growing city will have a legitimate claim for more water.



In 1825 Governor De Witt Clinton hinted at the inevitability of this development when he stated that, "It may be laid down as an incontrovertible truth that no dense population can furnish from within its own limits an adequate supply of this indispensable accommodation ...."[10] Clinton's calculus created a symbiotic relationship between a rural resource and an urban need and bound the history of northern Westchester to New York's quest for water. Reviewing all the proposals, Colonel Clinton concluded that the Croton River source "may be considered as inexhaustible, as it is not all probable that the city will ever require more than it can provide." Colonel Clinton based his selection of the Croton on calculations of New York's population growth and concluded that a source larger than the Bronx River and the Rye Ponds was required. Indeed, Clinton's calculations linked New York's population curve to the proportionate expansion of the Croton River dams and watershed.

Clinton's report, a New York State Supreme Court ruling against the Manhattan Company, and the loss of around 3,000 lives from the cholera epidemic of 1832 pushed the Common Council and the State Legislature to act. On February 26, 1833, Governor William Marcy appointed five water commissioners who, in turn, engaged Canvass White and Major David B. Douglass to survey all the possible sources. Based on White's and Douglass' report, the Water Commissioners recommended to the Common Council a dam of 130–150 feet in height and a reservoir to be built 6 miles from the mouth of the Croton.[11]

The Common Council agreed with the basic outline of the plan and submitted it to a public referendum where it easily carried. On May 7, 1835, the Council authorized a loan and appointed a chief engineer, Major Douglass. Work, however, did not begin on the Aqueduct for two more years until May 1837. The Water Commissioners placed the blame for these delays on Major Douglass and replaced him in October 1836 with John B. Jervis. But Douglass was only partially responsible; he served as an easy scapegoat. The delay was a result of the protest of the landowners in Westchester, whose property was the first rural resource to be taken (figure 40).

As early as 1833, when the State Legislature had granted the Water Commissioners power to conduct a survey, recommend a source, and condemn lands, Westchester farmers had opposed the project. They felt their property rights and their peace of mind threatened by the Croton project. In April 1835 Westchester resident Theodorus C. Van Wyck drove his one-horse cart into Manhattan and distributed broadsides opposing the project at several polling places.[12]

figure 40: Lt. Theophilus Schramke, **Map of Croton Watershed and Aqueduct Route**. From *Description of the New York Croton Aqueduct in English, German and French*, 1846
Courtesy William Lee Frost. Photo: J. Kennedy

In 1836 the State Legislature felt pressure to act but was uncertain about what to do. Although New York City voters endorsed the Aqueduct in the 1835 referendum, counter-pressure from Westchester petitioners who sought to reduce the powers of the Water Commissioners clouded the issue. Even concessions by the Water Commissioners to return any lands not specifically used for the Aqueduct and to build all the necessary fences and passes did not placate Westchesterites. A March 4, 1837, meeting of Westchester citizens, under the guidance of Van Wyck, prepared a memorial to the legislature condemning the Water Commissioners for extending the boundaries of New York City and "invading the historic manor of Cortlandt and the County of Westchester."[13] The petitioners argued that because the State had granted the Water Commissioners the right to deprive owners of their property without their consent and against their will, that the Enabling Act was repugnant to the Constitutions of the United States and the State of New York.[14] They asked that the act be repealed and that they be left, "as all good citizens should be left, free from any such intrusion or disseizin, peaceably to enjoy, retain or dispose of their respective real estate and property, as to them, respectively shall seem meet."[15]

Writing nearly a century ago, historian Edward Wegmann dismissed the protest rhetoric of the memorial as part of the attempt by landowners to inflate their property values, make negotiations more difficult, and force the State to condemnation proceedings. Wegmann characterized the opposition as merely obstructionist, which of course is the way they must have appeared to a city water supply engineer.[16]

But from the standpoint of a Westchester resident, it may well have seemed like an assault on one's rights and property, an unconstitutional attack not only on one's land but on one's way of life as well[17] (figures 31 & 41). In their memorials to the State Legislature, they attacked the notion that the lands were taken for the public good. They argued that they understood the public to be synonymous with the interests of the people of the whole state and not, as in the case of the Aqueduct, with the exclusive interests of the people of the county of New York. Earlier takings for canals and roads were justified, according to the memorialists, because these improvements served the needs of the whole State.[18]

Similar protest rhetoric appeared in the other parts of the United States, such as in the Waltham–Lowell area of Massachusetts, where control over rivers and the commodification of water was also an issue. Merrimack Valley farmers, home owners, and small manufacturers protested the flooding of lands, the diverting of waters, and disruption of the local economy. It even reached the level of attempts at dam breaking.[19]

While Westchester residents did not go to such extremes as dam breaking, they expressed many of the same feelings of anger when they interfered with the work of the engineers, blocked surveying parties from certain properties and, on one or two occasions, assaulted the surveyors.[20] This was certainly more than a strategy by a few landowners or real estate speculators to raise property values. What was at stake for many of the small farmers and manufactures was control over their lands and their livelihood. Whatever forebodings local residents had expressed in these protests were confirmed on January 8, 1841, when heavy rain and melting snow destroyed 200 feet of the earth embankment of the nearly completed dam and created a freshet which sent water rushing down the Croton to its juncture with the Hudson. In its wake, earth and flood waters carved a path of ruin and death through the valley.

The *Hudson River Chronicle*, published in Ossining, provided a local view of the dam collapse:

... at about four o'clock on Friday morning the embankment gave way and the Croton ... rushed down its course with resistless force. It first encountered the mills and dwelling house of Mr. Samuyel Tompkins, an aged and infirm man had barely time to escape ... passing on and tearing up in its course earth, stones and trees it next reached the extensive rolling mills of the wire factory of the Messrs.

figure 41: **Untitled Survey of Farmland**, c.1835, ink on paper
Courtesy Jervis Public Library, drawing #291. Photo: G. R. Farley

Bailey, situated on the banks of the Croton which it instantly carried away, together with their dwelling houses and tenant houses, barns, etc.—making all together twelve buildings—and all their machinery, stock, furniture and goods, etc. This was an extensive establishment, and employed about fifty men, and was situated about two miles from the dam .... William Evans and Robert Smith, who were overtaken in their flight were obliged to ascend a cedar tree of smaller size, which was borne down by the ice, and floating timbers, into the current, and they were carried away amid their unavailing cries for assistance.... From this place the accumulated waters dashed furiously onward, along the valley of the Croton to its mouth, a distance of about three miles carrying away in its course, Quaker bridge, Holman's mills, and the old piers of the old Croton bridge.... All the bridges below the dam were carried away, and above the dam, Pines Bridge, and we are informed Wood's Bridge also—leaving no crossing over the Croton from its mouth to Golden's bridge ....[21]

The newspaper account provides us with the local view of the incident and tells a story of the cost in human lives and livelihood. One account estimated the damage to surrounding lands, houses, and buildings at $500,000, far exceeding the $60,000 cost to rebuild the dam.[22] The collapse of the Croton Dam also confirmed the deep anxieties many Americans held in the 19th century about man's attempt to control nature through technology. While the Dam appeared to distant City dwellers as a "beneficent servant," in Westchester it appeared at this moment to be a "monster" out of control and unleashing destructive forces.[23]

The full horror of the tragedy was ignored by the cavalier response of the engineers who sought to minimize controversy. Chief Engineer Jervis arrived within a few hours, evaluated the damage, and reported to the Water Commissioners. Jervis tersely concluded, "it appears three lives were lost one at the dam and two at Bailey's wire factory."[24] While such language might simply reflect reporting conventions of engineers it also had the effect of belittling the loss of life and property. Left with only such insensitive clinical official reports of the incident one might conclude that this was a minor, somewhat costly interruption in the construction timetable. Westchester residents knew otherwise.

Not only was the community around the lower Croton uprooted by the dam collapse, but the topography and economic utility of the river were changed. Before the collapse, the Croton River was deep enough for sloops and barges to reach the mills and factories that lay along its route; its waters provided power and transportation. Even before the dam collapse, Westchester residents and Croton businessmen recognized the competitive economic threat the Aqueduct represented. The 1837 "Memorial To the New York State Legislature" charged New York City with attempting to monopolize the trade and commerce of the State at the expense of other counties. The memorialists complained that if the "river waters of Westchester County are to be taken from it, how is it to rise in arts and manufacture and farming?"[25] They saw the City's action as analogous to the citizens of Westchester "requiring a part of the harbor of New York be shut up, so that the population and trade of their County might increase."[26] They also suggested that New York's population with its limited supply of water may have reached its natural limits. A public recognition of this fact would compel people to "locate in other counties on the Hudson River and in other places in the state and the commercial trading cities of the Hudson would increase in population and competition ..." and "... the people of the state would be better served."[27] Indeed, the collapse of the Dam fulfilled the worst fears of Westchesterites about the economic threat of the Aqueduct.

Enterprising New Englanders had also proposed a canal from Sharon Connecticut to Pines Bridge where it would link with the Hudson via the Croton River. If completed, such a canal would have diverted trade from New York and "infused the river with activity and enterprise."[28] Westchester communities on the Croton would have become key towns on the waterway, farm production would have been stimulated, and the population would have grown. While this certainly would not have fundamentally challenged New York City's economic dominance, such a canal would have stimulated the economy of northern Westchester. But that was not to be.

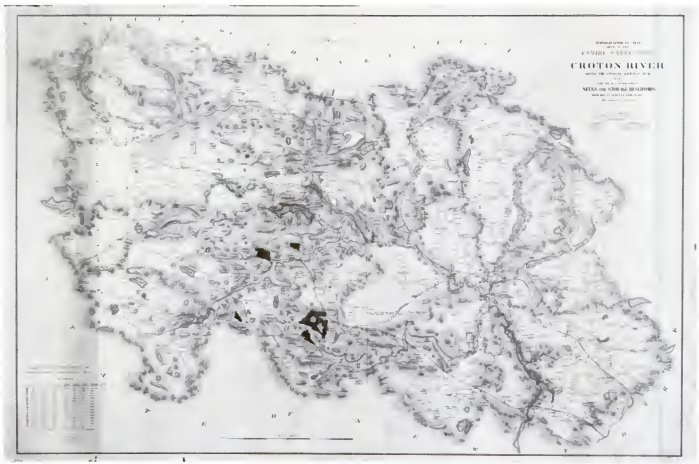
The collapsed dam permanently impaired the navigability of the

Croton and the adjacent Hudson. Rocks, mud, and debris covered the mouth of the Croton.[29] With the loss of this critical transportation link, the economic development of the Croton River and the Valley was limited. For instance, the Underhill family had operated a farm and successful grist mill on the Croton near Quaker Bridge for half a century, until the dam collapse. At high tide, merchant schooners and sloops had transported wheat up-river to the Underhill mills and returned loaded with flour for the New York market. But in 1841, the Underhills gave up the milling business, citing the shortage of water power and the property damage caused by the dam collapse.[30]

The transformation of northern Westchester County was not only the result of a dam collapse but was inherent in the creation of a reservoir and watershed for the Croton Aqueduct (figure 2). The reservoir, created by the dam was called Croton Lake, covered about 400 acres, and extended for 5 miles into the towns of New Castle, Bedford, and Somers where farms, family residences, and businesses had to be relocated. Future plans for the construction of new dams and reservoirs would trigger new battles over old issues during the last half of the 19th century.

But the pressure on Westchester water resources did not abate either. Demand for water from New York City outdistanced their earlier projected needs and within two decades the City again found itself in a water crisis.[31] While there was some waste, the increased demand came from a higher standard of living in part caused by bath tubs, shower baths, and water closets.[32] In 1858 in response to this new demand, the City commissioned a topographical map of the entire watershed, including recommended sites for additional reservoirs and dams in Westchester and Putnam Counties[33] (figure 42). The topographical map was a master plan for appropriating more water and land and, as a result, for the next 70 years, local residents faced condemnation proceedings and a replaying of the original debate of 1834–41.[34]

In the second half of the 19th century, while New York City's population and water needs surged, reservoirs were developed at Boyd's Corner in Putnam, the Middle and West Branches of the Croton, the Muscoot River in Westchester and Putnam, and at a series of ponds and lakes in the surrounding areas. This expansion culminated in the construction of the New Croton Aqueduct in 1891, which involved not only the usual condemnations but de-



struction of the original village of Katonah (figure 43).

In sum, the old Croton Aqueduct had initiated a process which subordinated the needs of Westchester County to those of New York City and inadvertently checked its economic development as well. Not surprisingly, the Croton Aqueduct undercut the economic independence of Westchester County doing so within the same decade that the railroad fixed the County's dependent character as a residential suburb of New York City. Ironically the key player in this dual process of suburbanization was John B. Jervis who served as the Chief Engineer of the Croton Aqueduct and Supervisor for the Hudson River Railroad.

The Aqueduct transformed northern Westchester, shifting population from the north of the County to the south in the 1840s[35] (figure 39). At the same time, the transportation revolution brought the New York and Harlem Railroad to White Plains in 1844 and the New York Central and Hudson to the river towns of Westchester in 1851. The coming of the railroad to Westchester accelerated the process initiated by the Croton Aqueduct, and together they transformed the County from a self-sustaining economic region to a dependent suburb of New York City.[36]

figure 42, left: **Topographical Map Showing the Entire Watershed of Croton River above the Croton Aqueduct Dam**, 1858, hand-colored lithograph
Courtesy Jervis Public Library, drawing #148. Photo: G. R. Farley

figure 43, above: **New Croton Dam under Construction**, c.1890, photograph
Courtesy Ossining Historical Society Museum, 58.99.65 (not in exhibition)
Photo: J. Kennedy

Notes

1. Two basic works share this urban perspective. Nelson Blake, in *Water for Cities: A History of the Urban Water Supply Problem in the United States* (Syracuse: Syracuse University Press, 1956), deals with the cities of New York, Philadelphia, Baltimore, and Boston. Charles Wegmann and Charles H. Weidner, in *Water for A City: A History of New York's Problem from the Beginning to the Delaware River System* (New Brunswick, New Jersey: Rutgers University Press, 1974), extend the story into the 20th century with a focus on New York City. Weidner's family had been displaced by the Catskill Aqueduct and, as a result, his work, though it still remains urban-centered, shows more concern for these kinds of issues.

2. Edward Wegmann's *The Water Supply of The City of New York 1638-1895* (New York: John Wiley, 1896) underscores the sense of urgency about the City's quest for water. Wegmann was a member of the engineering staff responsible for developing New York's water supply and wrote several books on dams and waterworks.

3. Wegmann, pp.6-7; Weidner, p.18.

4. Wegmann, pp.13-14; Weidner, p.24; Blake, p.110.

5. The experience of John B. Jervis, the chief engineer, underscored this conceptual link. Prior to becoming chief engineer on the Croton project Jervis served his apprenticeship on the Erie, the Delaware and Hudson and the Chenango canals.

6. Weidner, p.26.

7. Blake, p.132.

8. *Ibid.*, pp.28-29.

9. Weidner, p.26.

10. *Ibid.*, p.29.

11. *Ibid.*, p.36.

12. Blake, p.142.

13. *Westchester Herald*, 7 March 1837.

14. Blake, p.148.

15. *Ibid.*

16. Weidner, p.38.

17. The ideas of the Westchester protesters are detailed in their 1837 "Memorial to the New York State Legislature" which was printed in the March 7 and 14, editions of the *Westchester Herald*.

18. *Westchester Herald*, 7 March 1837.

19. Theodore I. Steinberg, "Dam Breaking in the 19th Century Merrimack Valley: Water, Social Conflict, and the Waltham Valley," *The Journal of Social History* v.24 (Fall 1990), #1, 31. The argument is more fully developed in Steinberg's *Nature Incorporated: Industrialization and the Waters of New England* (New York: Cambridge University Press. 1991).

20. Blake, p.148.

21. *Hudson River Chronicle*, 12 January 1841.

22. Alva P. French, *History of Westchester County, New York* (New York: Lewis Historical Publishing Co., 1925), vol. I, 348 also see Renada Hoffman, "The Night the Dam Broke," *Westchester Historian*, vol. 44 (Fall 1968) #4, pp.87-89.

23. John F. Kasson, *Technology and Republican Values in America. 1776-1900* (New York: Grossman Publishers, 1976), p.165.

24. F. Daniel Larkin, *John B. Jervis: An American Engineering Pioneer* (Ames, Iowa: Iowa State University Press, 1990), p.70.

25. *Westchester Herald*, 14 March 1837.

26. *Ibid.*

27. *Ibid.*

28. Herbert B. Howe, "The Croton Valley," *Westchester County Historical Society Bulletin*, vol. 25 (July 1949) #3, 77-86.

29. French, p.348.

30. Frederick A. Underhill, "The Underhill's Mill on the Croton," *Westchester County Historical Society Quarterly Bulletin* (July 1943) #3-4, 40-48.

31. Weidner, pp.52-58.

32. Blake, pp.269-270. Jean-Pierre Goubert, in *The Conquest of Water* (Princeton, New Jersey: Princeton University Press, 1989), examines the social and cultural concuest of water in France. Goubert, in the first part of his work, "Water, Purity and Hygiene," discusses many of the health issues which troubled the French and also beset American cities.

33. French, I, 351.

34. Frank E. Sanchis, *American Architecture: Westchester County, New York. Colonial to Contemporary* (North River Press, 1977), p.485.

35. Susan Cochrane Swanson and Elizabeth Green Fuller, *Westchester County: A Pictorial History* (Elmsford: Westchester County Historical Society, 1989), p.52; Richard M. Lederer, Jr., "Population Tables for Westchester County 1698-1980," *The Historian* (Westchester County Historical Society).

36. One local historian concluded that the strongest bond between the metropolis and Westchester in 1841 was the Croton River. Howe, p.83.

CROTON AQUEDUCT at CLENDINNING VALLEY

Celebrating the Aqueduct
Pastoral and Urban Ideals

Laura Vookles Hardin

figure 44, above: Fayette B. Tower, **Croton Aqueduct at Clendinning** [sic] **Valley**, c.1842, ink on paper
Courtesy Mrs. Helen Tower Wilson. Photo: T. Harnik

figure 45, below: Fayette B. Tower, **Croton Aqueduct at Clendinning** [sic] **Valley**, from *Illustrations of the Croton Aqueduct*, 1843, engraved by William James Bennett
Courtesy Mrs. Helen Tower Wilson (different version in exhibition)
Photo: T. Harnik

The Old Croton Aqueduct was built during the period when the appreciation of American landscape and landscape painting came of age. Though Thomas Cole's first trip to the Catskills and the public notice of his resultant "Hudson River School" paintings occurred over 10 years before ground was broken on the Aqueduct, the debate over the value of American versus European landscapes and art continued for many years.[1] The enduring popularity of pastoral imagery alongside more sublime expressions of American landscape painting reflected a nationalistic ideal to reconcile progress with nature, to preserve a "middle ground" between wilderness and urban life.[2] At the same time, Americans longed to place the United States in a cultural continuum of noble historical progress, and aqueducts symbolized the achievements of great civilizations. Technological progress was avidly desired, yet on some level, viewed with ambivalence.[3] Thomas Cole depicted the fate of corrupt nations in his *Course of Empire* series for the art gallery of New York City art patron Lumen Reed (1833–36, now in the collection of The New-York Historical Society).

The Croton Aqueduct's imagery—in public celebration, written accounts, popular engraving and advertisements, as well as fine art—reflects this cultural response to technology and progress in the mid-19th century and the iconography of its expression. The Croton Water system had the advantage of historical associations with aqueducts of the past, bringing to the City and countryside associations with the classical heritage and vistas of Europe. A majority of 19th-century descriptions and representations promote the Aqueduct as a paragon of urban achievement, yet also invoke arcadian imagery. By focusing on the bucolic quality of its setting, many contemporary representations, like those in assistant engineer Fayette B. Tower's book *Illustrations of the Croton Aqueduct* (1843), implied that the Aqueduct, while bringing New York City the necessary water to grow into a teaming metropolis, fit harmoniously into pastoral ideals of the landscape and, in fact, enhanced it.

The arrival of Croton water in New York City, on July 4, 1842, engendered a great deal of public excitement. Though the official celebration was more than 3 months away, citizens crowded the parapet of the great Distributing Reservoir at 42nd Street to watch it fill with water.[4] In a diary entry of 1842, ex-Major Philip Hone exclaimed, "Nothing is talked of or thought of in New York but Croton water."[5] City officials planned a grand celebration for October 14, to allow time for distribution to proceed into the homes and new public fountains.[6] The multi-faceted event featured a day off from work for the citizens, a procession from Battery Park to the City Hall Park, and the ringing of church bells throughout the City (figure 46). The lengthy parade included public officials, fire companies, visiting dignitaries, engineers, contractors and workers on the Aqueduct, as well as representatives of many professions, trades, and the temperance movement—all stakeholders in the success and impact of the Croton Aqueduct.[7]

In imagining the Aqueduct and how it would affect their lives, New Yorkers hoped for an end to the devastating fires and epidemics plaguing their city—many also hoped that drunkenness would be reduced with the availability of water palatable without the addition of alcohol.[8] George P. Morris' "The Croton Ode," which was sung at the close of the parade with music "adapted" from Rossini's opera *Amida* by Sidney Pearson, gave poetic expression to these desires, amid copious classical and biblical symbolism:

Gushing from this living fountain,
Music pours a falling strain,
As the Goddess of the Mountain,
Comes with all the sparkling train ....
Eden's arch of promise bending
over her translucent brow ....
Let intemperance greet her too,
And the heat of his delusion
Sprinkle with this mountain-dew.
Water leaps as if delighted,
While her conquered foes retire!
Pale Contagion flies affrighted
with the baffled demon Fire ....[9]

figure 46: J. F. Atwill, publisher, **Croton Water Celebration**, 1842, lithographed music title for "The Croton Ode"
Courtesy The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2036

Charles King's *A Memoir of the Construction, Cost and Capacity of the Croton Aqueduct ... together with an account of the Civic Celebration* (1843) features the most comprehensive description of the Croton Aqueduct Celebration. Commissioned by the politicians responsible for the Aqueduct, his work can be viewed both as an urban chronicle and partisan political statement. King filled his compendium not only with verbatim reprintings of many official reports, but also histrionic praise for the great public work, making, as did Fayette Tower, the requisite comparison to renowned aqueducts of the Old World. By including the aqueducts of the New World Indians, King and Tower affirmed the associations of this part of the world with classical antiquity.

King, a merchant and editor of the *New York American*,[10] also used weighty rhetoric to stress American superiority in achieving such a great public work by the vote and fiscal commitment of civic-minded citizens, rather than by imperial decree. Making more than one reference to its construction by freemen, King argued American democracy, surpassing corrupt civilizations of the past, would avoid their fall into desolation. Such pointed commentary can hardly fail to be inspired by the growing problems of the slavery issue in the United States: "The whole work was executed by contractors, employing free labor, was paid for by a single city, where slavery is unknown ...."[11] In reporting the celebration parade, the *Morning Post* also revealed a tendency to romanticize the workers: "The workmen on the Aqueduct too, with all their appliances, were in the procession; those noble fellows went through their operation of honest pipe-laying with an adroitness truly admirable."[12] As made clear by Tema Harnik, this romantic description contrasts sharply with the realities of the workers' actual experience. No analogous visual images of workers date from this time period.[13]

In referring to the Croton Lake created by the Dam as the "Fountain Reservoir," Fayette Tower probably used the phrase as a double connotation of the organic water source and the man-made. Natural fountains were an ancient symbol of life and salvation, and this imagery opened "The Croton Ode." Public ornamental fountains were a luxury made possible by the Aqueduct in addition to the essential services it provided. A source of civic pride, they symbolized both the sure power and plenitude of the water supply. Tower and King both made note of the historical associations of fountains, as both functional and artistic termini of famous aqueducts. King was enthusiastic about the image of conspicuous consumption inherent in the Croton fountains: "Its [the water system's] copiousness of waters is so great, that two of its fountains daily throw away more water, than suffices for the supply of other larger cities .... there is scarcely any feature of the work more imposing and magnificent than the volume of water which its fountains pour out in perennial flow, and the height to which they are projected."[14]

The impact of the Croton water on the public mind is suggested by its commercial use. Through not only visual symbolism, but also merely the suggestive words "Croton Water," advertisers could attract attention to their products and services. Fountain imagery as a symbol of the Aqueduct was prolific in popular art and advertising. A notice in *The Evening Post*, October 15, 1842, for Atwill

figure 47: F. Jones, **Thomas Dusenbury, Plumber ... Croton Water**, color lithograph advertisement
Courtesy The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2484a

Company's sheet music of the "Ode" advertised the fact that its title page featured the City Hall Fountain (figure 46). The image of the fountain was also employed in advertisements for indoor plumbing and soda water (figure 47). Promotions of these products and services illustrate the possibilities for improved living conditions in New York City and reveal the response of private enterprise to Croton water.[15]

Tower's engraved *View of the Jet at Harlem River* documents the "Maid of the Mist," a fountain spray the engineers created by releasing some of the pressurized water from the inverted siphon that supplied the City until High Bridge could be completed.[16] Tower's description of the seemingly "natural" geyser contrasts it with urban fountains:

> *The scenery around this fountain added much to its beauty, there it stood—a whitened column rising from the river ... waving like a forest tree as the winds swayed it, with the rainbow tints resting upon its spray, while on either side the wooded hills arose to rival its height: all around us was of* nature; *no marble basin—no allegorical figures, wrought with exquisite touches of* art *to lure the eye, but a fountain where nature had adorned the place with the grandeur and beauty of her rude hills and mountain scenery.*[17]

The cult of nature appreciation had also infiltrated non-art circles in the mid-19th century—revealing the still close connection between the ideals of art and science during this period.[18] In promoting a meeting of art and engineering, Tower's text integrates a history of ancient and modern aqueducts and descriptions not only of the building of the Croton Aqueduct but also the beauty of its surroundings and how it complemented them. For example, he noted that the clearing of the area around the Dam and the juxtaposition with man-made art had mitigated the wilderness and added to the area's inherent beauty. While some of Tower's illustrations of the Aqueduct are technical plans, the vast majority are picturesque "*views*" of the main structures along the route, engraved by well known professional artists from his own ink and wash "sketches taken for my own satisfaction ...."[19] Nearly all partake of the same pictorial and verbal rhetoric—he viewed the Aqueduct as an enhancement of its surroundings, balanced in scale with other elements of the landscape and in harmony with the rural activities which took place uninterrupted around it. The prints depict people walking on country lanes, herding cows, driving rustic carts, pausing at work to admire the scene, or engaged in rural recreational pursuits, like fishing or hunting.[20] *Croton Aqueduct at Clendenning Valley* is an especially good example of this pastoral format. Tower's initial drawing for the composition[21] included a lone figure; but in reconceiving the illustration for his book, he, or possibly engraver William J. Bennett, added additional rustic figures and several cows, a quintessential pastoral reference[22] (figsures 44 & 45). Characters were also added to the final versions of *Aqueduct Bridge for Roadway*, also engraved by Bennett, and *Croton Aqueduct at Jewell's Brook*, engraved by John William Hill.

"I gain information and pleasure by talking with the artists who are at work for me ...," Tower wrote to his brother Charlemagne on December 8, 1842.[23] The engravers he employed included Napoleon Gimbrede and Stephen H. Gimber, as well as Bennett and Hill, all well-established in New York. Bennett's watercolor *Fishermen at High Bridge* (1844, The New York Public Library) and John William Hill's watercolor of *High Bridge* (figure 48), exhibited at the American Art-Union in 1848,[24] reveal their continued interest in the Aqueduct as subject matter.

Most popular engravings and oil paintings of the Aqueduct display an iconographical pattern similar to that of Tower. But indexes of art exhibitions at the Art-Union and the National Academy of Design suggest only a mild curiosity on the part of artists in features of the Aqueduct. A number of works, such as those by Tower's engravers Hill and Bennett, are by artists with specific reasons to portray the Aqueduct. For example, Robert Havell, who displayed his painting of the Dam at the National Academy of Design in 1843, lived in nearby Ossining, one of the Aqueduct communities[25] (figure 14).

Only a few pictures suggested the massive scale of the

figure 48: John William Hill, **High Bridge**, c.1848, watercolor on paper
Courtesy Richard York Gallery, New York, NY. Photo: All Elai

Aqueduct or its intrusion over its setting. Tower's own image of the *Aqueduct Bridge Sing Sing* (figure 16) and a similar oil painting by Frederick Styles, *View of the Arch and Whitson's Grist Mill* (Ossining Historical Society) depicted a point where a massive arch carried the Aqueduct was carried over an existing mill. Yet while this new technology seemed to overwhelm the old, it did accomodate it.

Seemingly more intrigued with the Westchester landscape, Tower illustrated the Reservoirs within the city limits in a much more technical fashion, focusing on the design of the structures. During the early years of the Aqueduct's operation, the Murray Hill Distributing Reservoir, pictured on the verso of the official celebration coin, was one of the most frequently depicted features of the Aqueduct. This Egyptian-style structure was designed by Jervis with an eye to both its efficient water function and its public perception.[26] The design emphasized the solidity necessary to contain such a vast amount of water; at the same time it harked back to the great achievements of an ancient civilization which had harnessed water for irrigation purposes. In this vein, the *Evening Post* remarked appreciatively:

This is the most stupendous mass of masonry we have ever seen, or which probably exists in this country .... the walls are strengthened by pilasters on each corner ... and by one at the center of each side ...[27]

While a few published views, such as Nathaniel Currier's 1842 lithograph *View of the Distributing Reservoir on Murray's Hill—City of New York*, used scale and stark composition to emphasize its magnitude, others, such as J. Bornet's 1850 lithograph *Croton* [Distributing] *Reservoir* (figure 49) focused on the more rural aspects of that part of Manhattan.

The Dam, as well, symbolized the technological power of the Aqueduct. In confining the forces of nature, it likely invoked fearsome feelings of the sublime so desired in landscape paintings of the period. Yet popular imagery did not really exploit the potentially sublime drama of the image. Especially since the first dam had flooded, views of tourists enjoying strolls along the grassy banks of the sturdy structure—such as in the engraved frontispiece to King's book, from Havell's painting—may have seemed more appropriate and reassuring.

With the completion of High Bridge in 1848, artists and the public alike got an extraordinary arcadian view of the Aqueduct. As early as 1843, Tower had noted that High Bridge "... will be the most interesting work on the whole line of the Aqueduct, and in appearance rival the grandeur of similar works of the Ancient Romans."[28] Ironically, the "grandeur" of High Bridge related to a controversy surrounding its design. The Water Commissioners, though acknowledging the High Bridge's superior visual appeal, had approved John B. Jervis' lower structure: "... as far as architectural display is involved, the high bridge has the preference."[29] State Legislators had overruled them, however, specifying greater height and width of the arches. Lobbyists were mainly concerned with ensuring future navigation possibilities on the Harlem River; others objected that the homely low bridge would negatively affect local scenery. One anonymous individual, in a letter to the New York *American*, noted that the low bridge would "deprive the work of all that would render it an ornament to the city and the age in which we live."[30] Anticipating his requirement to build the more difficult and expensive structure, Jervis remarked: "I cannot say ... that I regret this as you know Engineers are prone to gratify a taste for the magnificent when there is a good reason for the execution of prominent works."[31]

Featured in Hill's watercolor, numerous popular engravings and, later, postcards and stereographs, High Bridge captured the public imagination. Around 1860, the Hudson River School artist David Johnson explored it in two oil paintings which continued the pastoral theme.[32] Art historian Gwendolyn Owens has discussed Johnson's fascination with natural and man-made bridges at this time, and suggested his possible nationalistic motives for showing that the American landscape had its share of picturesque architectural details. Johnson, she states, used the Bridge as an integral compositional element of the scenes, "not as an interruption in the natural order."[33] In the larger work, two diminutive figures serve the function of directing our gaze toward the distant arches forming a central horizontal line, set off by the diagonal of the foreground hill-

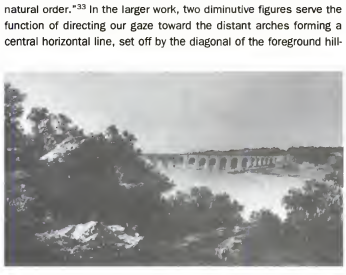


figure 49, above: J. Bornet, **Croton** [Distributing] **Reservoir**, 1850, published by J. Hoff, colored lithograph
Courtesy The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2103

figure 50, right: David Johnson, **Harlem River Aqueduct**, 1860, *oil on* canvas
Courtesy private collection

side (figure 50). In the smaller vertical study, two figures at the opposite bank of the river contemplate the quiet outdoor scene (cover illustration).

After the Civil War, even when New York City began to realize that simply expanding the original Aqueduct would not fulfill its growing needs, the High Bridge remained a popular image and recreational destination. Even as the metropolitan area quickly developed after the mid-19th century, most regional painters continued to focus on pastoral conventions, depicting the landscape with renewed impetus from the style and subject matter of the French Barbizon artists, who painted the rural landscape directly from nature. Charles Henry Miller's painterly study of High Bridge (c.1873, Walter and Lucille Rubin, not in exhibition) reflected these sensibilities, emphasizing the rural and picturesque character of the area; yet he also depicted the "traffic" along the Westchester side. Miller developed the composition into a monumental canvas which he entered in the 1875 National Academy of Design exhibition (figure 51). It was chosen for display in a prominent position and contributed in large part to his election as a full member; in 1876, his audience became international when the painting was displayed and awarded a medal at the Centennial Exposition in Philadelphia.[34] In its selection, one cannot help but speculate if the judges were attracted to its subject—the High Bridge had become one of the famed features of the New York landscape, and progress and technology were a highlight of the fair. This exposure and the painting's subsequent issuance as an etching probably made *High Bridge from Harlem Lane* the best known Aqueduct painting of this later period.

Artists, writers, and the general public also associated the Croton water system with park-like public amenities in both the City and the countryside—in the fountains, reservoirs, the Dam and Lake, and High Bridge. In fact, the concept of great public works projects in harmony with the landscape scenery precedes the Aqueduct in the Fairmount Waterworks at Philadelphia, begun in 1812. Thomas Doughty painted several views of the neo-classical buildings and their surroundings (figure 52), many of which were engraved by Cephus Childs around 1826. In his *Views of Philadelphia*, 1827–30, Childs summarized an arcadian view of technology:

The situation of Fairmount is exceedingly picturesque .... It is a favorite resort of the citizens, and the view of it is highly interesting, blending as it does the beauty of nature with the ornaments of useful art, and the gaiety of animation of groups of well dressed people.[35]

Similarly, as a public works project, the Aqueduct was appreciated for its recreational possibilities. Tower predicted that "... every thing in connection seems to indicate that the vicinity of the *Croton Dam* will be one of the resorts in summer seasons for the citizens of New York."[36] In addition to foreshadowing the appropriation of Westchester's countryside as parkland for city residents, he suggests the foreign visitor "*... will be pleased with a pedestrian tour along the line of work to the Fountain reservoir .... Besides becoming acquainted with the important features of the work, he may enjoy much that is beautiful in American scenery ... he may see the majestic palisades ... and the dark gorge where the Hudson emerges from the Highlands .... This country is interesting also from the associations with which it has been invested by the pen of our novelists ....*" In conjuring up every possible allusion to elements that added to the appreciation of landscape scenery, he went on to mention Washington Irving, the Dutch history of the area, and the capture of Major Andre.[37]

Of course, as Roger Panetta's essay makes clear, to farmers and landowners forced to cede property, this image of Westchester as a site of rural and recreational pleasures distorted the Aqueduct's impact. Still, tourists at Croton Lake constantly observed the "order and beauty" of the work at the Dam, according to Westchester historian Robert Bolton, Jr. in his 1848 text. While discussing the Aqueduct project only briefly, he nonetheless includes a sentimental poem "To Croton Lake," reprinted from the *Hudson River Chronicle*, about friends rowing on the man-made body of water (figure 2):

figure 51: Charles Henry Miller, **High Bridge from Harlem Lane**, 1873, oil on canvas
Courtesy Walter and Lucille Rubin

Unruffled calm thy bosom lies
Save where the oars the stillness break;
Nor do the breezes dare to rise,
To mar thy beauty, Croton Lake… [38]

High Bridge, which included a pedestrian walk-way, was a less distant excursion for City residents. In an 1866 travel guide, *The Hudson from the Wilderness to the Sea*, Benson Lossing noted, "Pleasant roads on both sides of the Harlem lead to the High Bridge, where full entertainment for man and horse may be had. The 'High Bridge' is a place of great resort in pleasant weather for those who love the road and rural scenery." Even closer at hand, the Murray Hill Distributing Reservoir was, at least at first, a welcome oasis for those who wanted to get away from more crowded areas of the City. Currier and Bornet both depicted the citizens on the parapet, from which one could admire the water inside, and the landscape view outside.

Well before the end of the century, the disharmonious juxtaposition of the geometric Receiving Reservoir to the newer picturesque landscaping style of Central Park (developed during the 1850s) eclipsed its popularity, and perhaps also that of Murray Hill. The Croton engineers' lake-like designs for additional reservoirs at the site reflected changing sensibilities favoring seemingly "natural" and "rustic" open spaces in urban settings. As an 1872 article in *Harper's Magazine* discussing the history, present-day operation and beautiful scenery of the water system, noted: "The old we need but glance at, for the new render them insignificant and unattractive."[39]

Several developments influenced the changing nature of popular imagery toward the end of the century. New techniques of printing wood engravings and advances in photography contributed to an explosion of popular illustrated literature. Numerous articles about the Aqueduct, which appeared in magazines ranging from *Harper's Weekly* to *Scientific American* after 1850, are embellished with not only the types of scenes described above but also—beginning with the enlargement of High Bridge in 1861—depictions of laborers at construction sites and overseers inside the mechanical workings. The lithographs of workers at the High Bridge construction site which were published in *Valentine's Manual* were actually copied from photographic documentation of this project (figure 53). This apparent shift in bias away from the pastoral romanticism of technology and increased fascination with the machinery of progress[40] coincided with New Yorkers' heightened awareness of their constantly expanding water system and the need for prudent use of water.

But in the early 1840s, America was still searching for self-confidence and self-definition. "Imagining" public works such as the Old Croton Aqueduct, in creating a symbolic imagery for the public, helped people place themselves in the context of human experience throughout the ages and encouraged faith in the expansionist concept of manifest destiny. The way the Aqueduct's meaning was constructed reflects an attempt to reconcile conflicting issues of "rural resources meeting urban needs." These hopeful ideals obscured the reality of situations such as New York's appropriation of Westchester's and Putnam's assets and the exploitation of workers who built projects like the Aqueduct. At the same time, the romantic view of the countryside through which it passed also calls to mind 19th-century views of the city as an unhealthful environment. Though probably not overtly intended as such, these scenes suggested the wholesome nature of the water being conveyed to New York City, by association with its source. The intended optimism of the Croton Aqueduct's image was destined to fade in the face of New York's crushing population growth and increased per capita use of water, which quickly proved that the water system, instead of serving generations to come, needed expansion after a mere 20 years. By the end of the century, its urbanizing achievement and symbolism had diminished in view of its suspect purity and decreasing role in the overall water system; and its image as a pastoral icon gradually shifted in the minds of local residents to the more modest nature trail it is enjoyed as today.

figure 52, above: Thomas Doughty (1793-1856), **Fairmount Water Works, Philadelphia**, c.1826, oil on canvas, 21$^{1}/_{4}$ x 29 inches
Courtesy Hirschl & Adler Galleries, Inc., New York (not in exhibition)
Photo: Helga Photo Studio

figure 53, right: Arthur Brown, **High Bridge During Construction of the Large Main, Viewed from the West Gate House, looking East**, 1861, three-color lithograph from *Valentine's Manual*
Courtesy private collection. Photo: B. Sigler

Notes

1. William H. Gerdts, "American Landscape Painting: Critical Judgments, 1730-1845," *The American Art Journal*, 17, No. 1 (1985), pp.45-54; Carol Troyon, "Retreat to Arcadia: American Landscape and the American Art Union," *The American Art Journal*, 23, No. 1 (1991), pp.20-37. Troyon points out that despite the general popularity of landscape paintings at this time, it was not until the late 1840s that they started playing a major role in the Art-Union's publications.

2. Troyon; Sarah Burns, *Pastoral Inventions: Rural Life in Nineteenth Century American Art and Culture* (Philadelphia: Temple University Press, 1989); Raymond O'Brien. *American Sublime: Landscape and Scenery of the Lower Hudson Valley* (Columbia University Press, New York, 1981), pp.170-175, 184-190, 224-225. Thomas Cole's seminal essay on American Scenery was not published until 1835.

3. These concepts are discussed extensively by Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (New York: Oxford University Press, 1964, 1967).

4. News of the event was reported in the *Westchester Herald*, Sing Sing, 5 July 1842 (Caleb Roscoe, Proprietor) and other sources.

5. Quoted in George H. Rappole, "The Old Croton Aqueduct," *Journal of the Society of Industrial Archeology*, 4, No. 1 (1978), p.23. He cites: Philip Hone, *The Diary of P.H.*, 1828-1851, ed. Allen Nevins (New York, 1936), pp.624-626.

6. Charles King, *A Memoir of the Construction, Cost and Capacity of the Croton Aqueduct ... together with an account of the Civic Celebration* (New York: Printed by Charles King, 1843), p.226; Charles Wesley, "Westchester County Watersheds as a supply for New York City," in Alvah P. French, *History of Westchester County*, New York, New York and Chicago, 1925, p.349.

7. King has the most complete description of the opening festivities, p.57 ff.

8. King, p.261; and *The Evening Post*, New York, October 15, 1842.

9. *The Evening Post*, New York, October 15, 1842; King, p.299-300. The poem was reprinted on silk souvenir ribbons, as well as published as sheet music by Atwill & Co. Broadsides with the text, printed by Nesbitt, were distributed during the celebration procession. A note at the bottom of the broadside describes the manner of its distribution (above artifacts coll. Museum of the City of New York).

10. Joseph G. E. Hopkins, ed., *Concise Dictionary of American Biography* (New York: Charles Scribner's Sons, 1964), p.526.

11. King, p.221.

12. Reprinted in *The Evening Post*, New York, October 15, 1842.

13. Lt. Theophilus Schramke, *Description of the New York Croton Aqueduct in English, German and French* (New York and Berlin: printed by Munzt, 1846). Schramke published the only known illustration of workers on the initial phase of the Aqueduct project. A straightforward view of masonry work in a tunnel, his original ink and wash drawing is in the collection of the Engineering Societies' Library (ESL Information Services).

14. King, p.221.

15. The many commercial listings of private plumbers wishing to obtain work bringing Croton water into residences (for example in several 1842 issues of the New York *The Evening Post*) bring to mind a number of issues, not the least of which is the fact that—though elaborate indoor facilities were now available—they were available at a price. As Jeffrey Kroessler makes clear, the Aqueduct brought water to a city filled with many buildings not designed for such indoor services.

16. Fayette B. Tower, *Illustrations of the Croton Aqueduct* (New York and London: Wiley & Putnam, 1843), pp.111-112, plate XX. Also described in *The Citizen and Strangers' Pictorial and Business Directory for the City of New York and Its Vicinity*, 1853, pp.227, 247, which called it "Maid of the Mist." Tower called it the "Jet."

17. Tower, p.112 (his italics).

18. In researching the Aqueduct project the first chief engineer, David Bates Douglas, had written to artist and inventor Samuel F. B. Morse for his opinion of European Aqueducts—Morse responded by saying he knew them only as a painter, rather than having any practical information. (Letter in Douglass Papers, in The Archives, Warren Hunting Smith Library, Hobart and William Smith College, Geneva, NY).

19. Tower, preface (his italics).

20. Such classic Romantic pictorial techniques are discussed, in general and in reference to other artworks, by O'Brien, Burns, and others.

21. Helen Tower Wilson, a descendant of Tower, owns several of the original drawings, as well as numerous personal letters by Tower.

22. O'Brien discusses the cow image, borrowed from the tradition of English landscape paintings in the pastoral mode, pp.186, 316 (n.72).

23. Private collection, Helen Tower Wilson, along with other related letters. Tower apparently produced his book under his own enterprise and with his own money. Later, he also wrote that the book was well received.

24. Mary Bartlett Cowdrey, *American Academy of Fine Arts and American Art-Union Exhibition Record*, 1816-1852 (New York: The New York Historical Society, 1953), p.185. According to York Gallery, the figures in Hill's watercolor may be dredging the road, yet their rural surroundings and manner of work still connote the countryside more than urban progress.

25. Though the painting was published as the work of Agate in *A Celebration of Westchester: Arts and Decoration of Three Hundred Years (Three exhibitions in honor of Westchester County's Tricentennial)* (The Scarsdale Historical Society, 1982), p.34, The Ossining Historical Society also suggests an alternate attribution to T. J. Carmichael, who lived nearby and worked on the Aqueduct project in that town. A painting of the Sing Sing Aqueduct Bridge by a T. J. Carmichael (location unknown, unless it may be this one) was exhibited at the National Academy of Design in 1841.

26. F. Daniel Larkin, *John B. Jervis: An American Engineering Pioneer* (Ames, Iowa: Iowa State University Press, 1990), p.79.

27. *The Evening Post*, New York, October 15, 1842.

28. Tower, p.110.

29. Larkin, p.72.

30. Quoted in Larry D. Lankton, "Valley Crossings on the Old Croton Aqueduct," *Journal of the Society of Industrial Archeology*, 4, No. 1 (1978), p.39. Lankton provides a good summary of the controversy.

31. Quoted in Larkin, p.75. From a personal letter to Colonel Albert, written before the legislation was passed.

32. This was just before the installation of the larger pipeline at High Bridge, a major construction project which raised the level of the parapet, but this author has not found any specific evidence to suggest that Johnson was motivated to paint the bridge by interest in that aspect of the project.

33. Gwendolyn Owens, *Nature Transcribed: The Landscapes and Still Lifes of David Johnson (1827-1908)* (Herbert F. Johnson Museum of Art, Distributed by University Press of New England, Hanover and London, 1988), pp.23-25. Though Owens does not suggest this connection, it is at least marginally possible that the larger work is *Scene on the Harlem River*, exhibited at the National Academy of Design in 1861.

34. Ronald G. Pisano, *Charles Henry Miller: the Artistic Discoverer of the Little Continent of Long Island* (Stony Brook, NY: The Museums at Stony Brook, 1979), pp.9-12.

35. Wendell Garrett, *Neo-Classicism in America, Inspiration and Innovation, 1810-1840*, introd. Stuart Feld (New York: Hirschl & Adler Galleries, 1991), pp.104-105. In referring to technology as a "useful art," Childs harks back to an earlier time when the distinctions between science and art had not diverged so much as in modern times. Fayette Tower also makes several references to their handiwork and the Aqueduct structures as "art."

36. Tower, p.101.

37. Tower, p.123.

38. Robert Bolton, Jr., *History of the County of Westchester from its first settlement to the Present Time* (New York: printed by Alexander S. Gould, 1848), p.396. The *Hudson River Chronicle* was a Westchester publication; Bolton notes no author for the poem.

39. Benson Lossing, *The Hudson from the Wilderness to the Sea* (Troy, New York: H. 8. Nims & Co., 1866), p.371.

40. "From Croton to Town," *Harper's Magazine*, July 6, 1872.

41. *The Great East River Bridge* (Brooklyn Museum of Art: exclusively distributed to the Trade by Abrams, 1983). In the first of several essays by different authors, Deborah Nevins quotes the opening day speech by N.Y. Congressman Abram Hewitt, "Could there be a more astonishing exhibition of the power of man to change nature...." The construction and cultural reaction to this later civic project (1869-1883) makes an interesting comparison with the Aqueduct's story.

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Lenders to the Exhibition

The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges, Geneva, NY

Briarcliff Manor-Scarborough Historical Society, Briarcliff, NY

Dana and Jeffrey Cooley Gallery

Cornelia Cotton Gallery

Delaware and Hudson Canal Historical Society, High Falls, NY

Dobbs Ferry Historical Society, Dobbs Ferry, NY

ESL Information Servies, Engineering Societies' Library, New York, NY

Putnam County Historical Society, Cold Spring, NY

William Lee Frost

The Historical Society of the Tarrytowns, Tarrytown, NY

The Hudson River Museum of Westchester, Yonkers, NY

Jervis Public Library, Rome, NY

Kennedy Galleries, New York, NY

Museum of the City of New York, NY

The New-York Historical Society, New York, NY

The New York Public Library, New York, NY

New York State Museum, Albany, NY

Ossining Historical Society Museum, Ossining, NY

Anthony Peluso

Lucille and Walter Rubin

Smithsonian Institution, National Museum of American History, Division of Engineering and Industry, Washington, D.C.

Westchester County Archives, Andrew J. Spano, County Clerk

Addison Miller White

Mrs. Helen Tower Wilson

Richard York Gallery, New York, NY

Private Collectors

Checklist of the Exhibition

Note: Artists dates, when known, appear in first reference.

Introduction

Rusty Russell, **Interior of the Old Croton Aqueduct**, 1992
Black and white photograph
Courtesy of the photographer

Nicolino V. Calyo (1799–1884), **The Great Fire, 1835 (As Seen from the Bank of America, corner of Wall and William Streets)**
Colored aquatint on paper; published by L. P. Clover
Reproduction, courtesy of the Museum of the City of New York, 52.100.18

Fayette B. Tower (1817–1857), **Aqueduct at Spoletto** [sic]
In *Illustrations of the Croton Aqueduct*, 1843
Engraved by Joseph Napoleon Gimbrede (1820– ?)
Reproduction, courtesy of The Historical Society of the Tarrytowns

Aqueduct Cross Section, c.1836–39
Ink and watercolor on paper in "Letter Book of John B. Jervis"
Reproduction, courtesy of the Jervis Public Library, Rome, NY

Arthur Brown, **High Bridge During Construction of the Large Main, Viewed from the West Gate House, Looking East**, 1861
SB Three-color lithograph from *Valentine's Manual*
Reproduction, courtesy private collection

James Renwick, Jr. (1818–1895), **Harlem River Bridge (High Bridge)**, c.1839–40
Watercolor and ink on paper in "Letter Book of John B. Jervis" (vol. II)
Reproduction, courtesy of the Jervis Public Library, Rome, NY

Lt. Theophilus Schramke, **Profile of Lower Part of Croton Aqueduct**, c.1842
Color lithograph, George Hayward's Lithography, NY; 10 x 38½ inches
Jervis Public Library, Rome, NY

Nathaniel Currier (1818–1888), **Hydrographic Map of the Counties of New York, Westchester, and Putnam and also showing the line of the Croton Aqueduct**, 1845
Color lithograph; 7⅛ x 10⅛ inches
Courtesy of William Lee Frost

Section 1: The Need for Water

The Collect Pond, c.1800
Illustration #17, *Hollyer's Old New York Views*
Reproduction, courtesy of The New-York Historical Society, New York

The Tea Water Pump at Roosevelt and Chatham Streets
Engraving
Reproduction, courtesy of the Museum of the City of New York

John Penniman (c.1817–1850), **Origin of Steam Navigation. Honor to Whom Honor is Due. A view of Collect Pond, N.Y.C., 1795**, 1846
Lithograph
Reproduction, courtesy of The New-York Historical Society, New York

Nicolino V. Calyo, **The Great Fire of 1835 ... Burning of the Merchants Exchange, NY, Dec. 16, 17, 1835**
Gouache on paper; 13 x 20⅜ inches
Museum of the City of New York, Bequest of Mrs. J. Insley Blair, in memory of Mr. and Mrs. J. Insley Blair, 52.100.7

Nicolino V. Calyo, **View of the Ruins after the Great Fire in NY, As Seen from Exchange Place**
Colored engraving by William James Bennett (1789–1844); published by L. P. Clover; 20⅜ x 27¾ inches
Museum of the City of New York, Bequest of Mrs. J. Insley Blair in memory of Mr. and Mrs. J. Insley Blair, 52.100.19

Hollow Log with Valve, used by The Manhattan Water Company, N.Y.C.
Wood and iron; 12 x 24 inches
The New-York Historical Society, New York, X.47

Section 2: The Plan to Meet the Need

Water Works Money of 1774
Wood-engraved illustration in Charles King's *A Memoir of the construction, costs and capacity of the Croton Aqueduct, compiled from official documents, together with an account of the civic celebration of the 14th October, 1842* (New York, 1843)
Reproduction from book, collection of The Hudson River Museum of Westchester, Gift of John Zukowsky

G. P. Hall and Sons, **Manhattan Company Reservoir, New York City**, 1825
Watercolor on paper; 10⅛ x 15⅞ inches
The J. Clarence Davies Collection, Museum of the City of New York, 29.100.1579

Fanny F. Palmer (c.1812–1876), **View on the Harlem River, New York, The Highbridge in the Distance** (Macomb's Dam), 1852
Color lithograph; published by Nathaniel Currier; 17 x 21½ inches
Kennedy Galleries, New York

C. Burton, **The Reservoir, Bowery**, 1831
Engraved by George W. Hatch (1805–1867) and James Smillie (1807–1885); printed by James R. Burton; published by G. Melksham Bourne; 2¾ x 3½ inches (image)
The Hudson River Museum of Westchester

Report of the Commissioners ... relative to supplying the City of New York with Pure and Wholesome Water, Document no. 36, November 1833
Printed report, with maps
Courtesy of William Lee Frost

Water Stock of the City of New York ($2000), 1849
Printed bond for expansion of Croton water system. 7⅛ x 10⅛ inches
Courtesy of William Lee Frost

Topographical Map Showing the Entire Watershed of Croton River above the Croton Aqueduct Dam, 1858
Hand-colored lithograph; 25¾ x 40 inches
Jervis Public Library, Rome, NY, drawing #148

Report of Mr. D. B. Douglass, In *Report of the Commissioners ... relative to supplying the City of New-York with Pure and wholesome water*, Document No. 44, February 1835
Printed report, with illustrations
The Hudson River Museum of Westchester

Aqueducts of the World
Engraving in *Encyclopedia Britannica*, 9th edition (New York, 1878), vol. II
Reproduction, courtesy of Dobbs Ferry Historical Society, Dobbs Ferry, NY

Letter from Samuel F. B. Morse, to David B. Douglass, 1833
Reproduction, courtesy of The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges, Geneva, NY

Fayette B. Tower, **Student Notebook Regarding World Architecture**, c.1830–35
Bound manuscript
Mrs. Helen Tower Wilson

Transverse Sections of Plans for the Croton Aqueduct (submitted by John B. Jervis in report of Dec. 23, 1836)
Ink and watercolor on paper; 18 1/2 x 26 3/8 inches
Jervis Public Library, Rome, NY, drawing #161

Sectional Drawing of Aqueduct Alternate Plan—copy II, c.1837
"Profiles of the Aqueduct on the Hudson River," "Ordinary Cutting," "Deep Cutting," "Section of the Aqueduct on the Inland Route from the Head of the Saw Mill River to the City"
Ink on paper; 9 3/4 x 14 1/2 inches
Jervis Public Library, Rome, NY, drawing #200

Plan of Supporting the Croton Aqueduct Across Ravines and Low Grounds, Dec. 27th 1836
Watercolor and ink on paper; 25 x 33 1/2 inches
Jervis Public Library, Rome, NY, drawing #235

Section 3: The Corps of Engineers

Portrait of Major David Bates Douglass (1790–1849), n.d.
Contemporary print from glass plate negative
Reproduction, courtesy of The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges, Geneva, NY

Frederick R. Spencer (1806–1875), **Portrait of John B. Jervis (1795–1885)**, c.1837
Oil on canvas; 30 x 25 1/4 inches
Jervis Public Library, Rome, NY (on permanent loan from Addison White)

George H. Hite (d.1880), **Portrait of John B. Jervis**
Oval miniature; 4 x 3 inches
Jervis Public Library, Rome, NY

John B. Jervis, **First Report to the Water Commissioners**, December 1836
Jervis Public Library, Rome, NY

Cast bronze letters "J B Jervis" (removed from High Bridge)
Mounted on oak panel: 10 x 48 inches
Smithsonian Institution, National Museum of American History, cat. #327,973

Unknown Artist, **Wedding Portrait of Fayette B. Tower and Anna Regina Phelps**, 1839–40
Watercolor on paper; 8 1/2 x 6 1/2 inches
Mrs. Helen Tower Wilson

Theophilus Schramke, **Description of the New York Croton Aqueduct in English, German and French**, 1846
Book with 20 plates. New York and Berlin: printed by Mundt
Courtesy of William Lee Frost

Cathleen Polgreen, **Aqueduct Overseer's House, Dobbs Ferry, NY**, built 1845
Reproduction from contemporary slide
Collection, Dobbs Ferry Historical Society, Dobbs Ferry, NY

Semi-Annual Report of the Water Commissioners for the Period ending December 31, 1847, Document No. 29, January 3, 1848 (cover signed by "Jas. Bremner")
The Hudson River Museum of Westchester

Letter from Fayette Tower to his mother, Mrs. D. T. Tower, from Sing Sing, March 7, 1839 (re: trying to find a job for his brother, and his transfer to High Bridge)
Mrs. Helen Tower Wilson

List of Engineering Inspectors employed on the 1st Division during the present month, in letter to John B. Jervis from Edmund French, Resident Engineer at Sing Sing, April 25, 1838
Jervis Public Library, Rome, NY

Section 4: The Engineering Design and Hydraulic Concepts

Fayette B. Tower, **View above the Croton Dam,** From *Illustrations of the Croton Aqueduct*, 1843
Engraved by William James Bennett; 5 1/2 x 10 1/2 inches (image)
Ossining Historical Society Museum

Fayette B. Tower, **View below the Croton Dam,** From *Illustrations of the Croton Aqueduct*, 1843
Engraved by Joseph Napoleon Gimbrede; 7 x 10 1/2 inches (image)
Ossining Historical Society Museum

Charles Robert Leslie (1794–1859), **View of the Croton Dam**, c.1852
Wood engraving (tinted) from unknown magazine; 5 1/4 x 7 inches (image)
Courtesy of William Lee Frost

Croton Dam showing the Gate House and the Road Bridge, 1863
From *Photographic Views of the High Bridge and the Gate Houses of the New Reservoir* (belonged to third Chief Engineer Alfred Wingate Craven); 20 1/4 x 28 1/4 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

Lt. Theophilus Schramke, **Croton Dam Design. Cross Section of Ogee Curve**, engraving in *Description of the New York Croton Aqueduct in English, German and French*, 1846
Reproduction, courtesy of William Lee Frost

Fayette B. Tower, **Tunnel & Gate Chamber at the Head of the Aqueduct,** In *Illustrations of the Croton Aqueduct*, 1843
Engraved by Stephen H. Gimber (1810–1862)
Reproduction, courtesy of The Historical Society of the Tarrytowns

Possibly by John B. Jervis, **Elevation of Regulating Gates** (at Croton Dam), c.1841
Watercolor and ink on paper; 22 3/4 x 33 inches
Jervis Public Library, Rome, NY, drawing #318

Fayette B. Tower, **Entrance Ventilator,** In *Illustrations of the Croton Aqueduct*, 1843
Engraved by Stephen H. Gimber
Reproduction, courtesy of The Historical Society of the Tarrytowns

Evelyn Fitzgerald, **Detail, Croton Aqueduct Ventilator Inscription**
Reproduction from contemporary slide
Collection, Dobbs Ferry Historical Society, Dobbs Ferry, NY

Possibly by John B. Jervis, **Aqueduct Bridge at Sing Sing** (plan and elevation), c.1837–39
Watercolor and ink on paper; 24 1/2 x 39 inches
Jervis Public Library, Rome, NY, drawing #317

Fayette B. Tower, **Croton Aqueduct at Sing Sing Kill**, c.1842
Ink on paper; 9 x 12 inches
Mrs. Helen Tower Wilson

David B. Douglass, **Land Takings Map #41: Land of Justice Dearman, Jewell and Stephen Tompkins**, 1836
Ink and watercolor on paper
Reproduction, courtesy of Westchester County Archives, Andrew J. Spano, County Clerk

Fayette B. Tower, **Jewell's Brook**, c.1842
Ink and wash on paper ; 10 x 6 1/2 inches
Mrs. Helen Tower Wilson

T. E. Sickels, **Viaduct near Saw-Mill River**, c.1837–39
Watercolor and ink on paper; 17 1/2 x 24 3/4 inches
Jervis Public Library, Rome, NY, drawing #245

George Hayward (c.1800– ?), **High Bridge**, 1850
Three-color lithograph from *Valentine's Manual*, 7 3/4 x 14 1/4 inches (image)
Private collection

Elevation of a High Bridge for Crossing Harlaem [sic] **River**, c.1839–40
Watercolor and ink on paper; 16 3/4 x 24 1/2 inches
Jervis Public Library, Rome, NY, drawing #249

High Bridge During the Construction of the Large Main. Viewed from the Westchester Side of the Harlem River, 1861; **Sing Sing Bridge, Croton Aqueduct, Showing the Road Bridge Underneath It**, 1863
From *Photographic Views of the High Bridge and the Gate Houses of the New Reservoir* (belonged to third Chief Engineer Alfred Wingate Craven); 20 1/8 x 28 1/4 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

Fayette B. Tower, **Aqueduct Bridge at Clendinning** [sic] **Valley**, c.1842
Pencil and wash on paper; 8 x 17 inches
Mrs. Helen Tower Wilson

Nathaniel Currier, **View of the Great Receiving Reservoir, Yorkville, City of New York**, 1842
Color lithograph; 8 1/4 x 12 3/4 inches
Courtesy of William Lee Frost

Stop Cock for 36-inch pipes, c.1841
Watercolor and ink on paper; 9 1/2 x 14 1/2 inches. Signed, LR: Pearson, CB, Pe and [?]"
Jervis Public Library, Rome, NY, drawing #240

Plan of Effluent Pipes in East Side of Receiving Reservoir at York Hill, c.1837–41
Watercolor and ink on paper; 25 3/8 x 37 1/2 inches
Jervis Public Library, Rome, NY, drawing #307

James Renwick, Jr., **Receiving Reservoir—Plan of Waste Weir, Sewer and Gatehouse of North Division**, c.1839–40
Ink and watercolor on cloth-backed paper; 25 x 38 1/4 inches
Jervis Public Library, Rome, NY, drawing #158

Fayette B. Tower, **Distributing Reservoir,** From *Illustrations of the Croton Aqueduct*, 1843
Engraved by Joseph Napoleon Gimbrede
Ossining Historical Society Museum

M. M., **View of the Distributing Reservoir ... from the Deaf & Dumb Institute, 50th St.**, 1847
Watercolor on paper; 2 7/16 x 3 1/2 inches
Museum of the City of New York, Gift of William M. Morgan, 34.166.27

Possibly by John B. Jervis, **Croton Aqueduct/Cornice of Distributing Reservoir**, c.1837–41
Ink and wash on paper; 25 1/2 x 17 1/2 inches. Inscription in pencil (incorrect): "Cornice Receiving Reservoir"
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

Nathaniel Currier, **Map of the City of New York, Shewing** [sic] **Sewers, Drains and Culverts**, 1847
Lithograph; 24 x 19 inches. Signed: "JB Jervis from JH Coffin"
Jervis Public Library, Rome, NY, drawing #166

Letter Books of John B. Jervis
Ink and watercolor on paper in bound volumes; 12 x 9 inches
Jervis Public Library, Rome, NY

Fayette B. Tower, **Illustrations of the Croton Aqueduct**, 1843
Book with 25 engraved plates (first plate unnumbered). New York and London: Wiley & Putnam. Presented by Tower to his brother, Julius
Mrs. Helen Tower Wilson

Names of Subscribers to *Illustrations of the Croton Aqueduct* **by F.B. Tower**, 1843
Printed, ink on paper, on which is written a letter: dated June 28, 1843
Mrs. Helen Tower Wilson

Section 5: Work Along the Line

David B. Douglass, **Water Survey**, 1833, 1834
Leather-bound notebooks, four volumes
The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges, Geneva, NY

Untitled Survey of Farmland, c.1835
Ink on paper; 16 1/2 x 24 inches
Jervis Public Library, Rome, NY, drawing #291

George Cartwright, **Survey of the Croton**, 1833
Ink on paper; 18 1/8 x 15 1/8 inches
The Archives, Warren Hunting Smith Library, Hobart and William Smith Colleges, Geneva, NY

David B. Douglass, **Land Takings Map #15: including Sing Sing Village**, 1836
Ink and watercolor on paper; 26 1/4 x 32 1/2
Courtesy of Westchester County Archives, Andrew J. Spano, County Clerk

David B. Douglass, **Land Takings Map #33: including the Old Dutch Church**, 1836; **Land Takings Map #48: including Saunders and Kidder property (and cemetery?), Hastings**, 1836; **Land Takings Map #70: including Fordham Church and Valentine Property**, 1836; **Land Takings Map #57: including property of L. Wells, corner Post Road and Tuckahoe Rd.**, 1836
Ink and watercolor on paper
Reproductions, courtesy of Westchester County Archives, Andrew J. Spano, County Clerk

Fayette B. Tower, **Over Railroad to Mr. Harvey's Marble Quarry, Hastings**, c.1842
Ink with watercolor wash on paper; 7 1/4 x 6 1/4 inches
Mrs. Helen Tower Wilson

David B. Douglass, **Land Takings Map #49: including Harvey's Marble Quarry**, 1836
Ink and watercolor on paper; 16 1/4 x 22 1/4 inches
Courtesy of Westchester County Archives, Andrew J. Spano, County Clerk

Section of the Aqueduct with Iron Lining, c.1837–39
Ink and watercolor on paper; 14 3/4 x 17 1/2 inches
Jervis Public Library, Rome, NY, drawing #205

Possibly by John B. Jervis, **Croton Aqueduct—Detail of Iron Pipes**, c.1839–40
Ink and watercolor on paper; 20 1/2 x 28 1/2 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

Iron Pipe (sample section), mid-19th century
Cast iron; 14 x 6 1/2 x 4 inches
Courtesy of the Putnam County Historical Society, Cold Spring, NY

Thomas K. Wharton (1814–1862), **Works of the West Point Foundry from the Head of the Ravine** (Cold Spring, New York), November 1832
Ink on paper in "Thomas K. Wharton Diary 1830–1834" (p.205)
Reproduction, courtesy Rare Books and manuscripts Division, The New York Public Library, Astor, Lenox and Tilden Foundations

An Improved Map of the Hudson River, with the Post Roads between N. York and Albany, Published by Harper & Bros., drawn & engraved especially for the tourist, 1836
Engraved map from unknown guidebook; 6 x 41 inches
Briarcliff Manor-Scarborough Historical Society

Details of a Device to Move Stone, c.1837
Ink and watercolor on linen-backed paper; 26 3/4 x 18 3/4 inches
Jervis Public Library, Rome, NY, drawing #87

Theophilus Schramke, **Croton Aqueduct. Method of Tunneling in Earth** (two men at work), c.1837–1846
Ink and watercolor on paper; 18 x 16 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

Method of Construction on steep side hills (Tarrytown Division), c.1837–39
Watercolor and ink on paper; 17 x 25 inches
Jervis Public Library, Rome, NY, drawing #199

Harlem River Bridge/Pile Driver, c.1839
Ink and watercolor on linen-backed paper; 24 1/2 x 32 1/2 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

Edmund French, Resident Engineer, **Articles furnished by the Water Commissioners and placed under the care of the Chief Engineer** (Sing Sing Office), Oct. 28, 1836
Manuscript. Jervis Public Library, Rome, NY

Inventory Articles belonging to the Offices of the Northern Division, N.Y.W.W
Manuscript
Jervis Public Library, Rome, NY

Andrew Meneeley's Manufacturing Establishment ... Levelling and Surveying Instruments ..., West Troy, NY
Printed advertisement, on which is written a letter to J.B. Jervis from Meneely, dated February 1, 1842
Jervis Public Library, Rome, NY

Field Lapdesk, (used on the Delaware and Hudson Canal project)
Wood; 13 3/4 x 16 x 12 1/4 inches
Delaware and Hudson Canal Historical Society, High Falls, NY
Gift of Mrs. Percy Ewen Smith, NJ

Note: The engineering instruments listed below are representative types from the period, similar to those which would have been used on the Croton Project.

Surveyor's Transit (used on the Delaware and Hudson Canal project), c.1822
Brass, glass, blue steel, 2 level vials; 20 x 17 x 8 1/2 inches
Delaware and Hudson Canal Historical Society, High Falls
Gift of Mrs. Virgil DeWitt, New Paltz, NY

Andrew Meneely, West Troy, NY, **Surveyor's Vernier Compass in Wooden Case**, c.1825–49
Brass, glass, blue steel, 1 level vial, wood; 3 x 16 x 7 inches
New York State Museum, Albany, NY, 42.3.1

Meneely & Oothout, West Troy, NY, **Surveyor's Compass in Wooden Case (no. 973)**, c.1825–49
Brass, glass, blue steel, 2 level vials, wood; 3 1/4 x 15 3/4 x 7 1/8 inches
New York State Museum, Albany, NY, 69.55. A-D

W & S Jones, 30 Holborn, London, **Surveyor's Brass Y-level** (used in the construction of the Erie Canal), c.1820
Brass, glass, level vial, wood; 6 x 25 1/4 x 3 1/2 inches
New York State Museum, Albany, NY, 46.2.1 a & b

Fayette B. Tower, **Worker's Camp** (building through trees)
Ink with wash on paper
Mrs. Helen Tower Wilson

Engineers' Quarters, in a Work Camp, Old Croton Aqueduct Project
Drawing in letter: Fayette B. Tower, from Sing Sing, to his mother, Mrs. D. T. Tower, Waterville, NY, November 5, 1837
Mrs. Helen Tower Wilson

General Improvement and Repairs of work on part of the ... Croton Aqueduct, 1847
Accounting sheets by division, signed by division supervisors (overseers), listing workers involved
Ink on paper; each 6 3/4 x 15 3/4 inches
Courtesy of William Lee Frost

William St. John Harper (1851–1910), **Shutting off the Croton at the Central Park Reservoir**
Wood engraving from *Harper's Weekly*, November 12, 1881
Courtesy of William Lee Frost

Repairing the Broken Pipes, 5th Avenue at 65th Street
Wood engraving (tinted) from *Frank Leslie's Illustrated Newspaper*, December 22, 1860; 7 x 9 1/2 inches
Cornelia Cotton Gallery

Notice. Croton Aqueduct. Sealed Proposals will be received .... for completing the embankment on the West side of the Aqueduct in 86th St., December 29, 1842
Broadside announcement to contractors
Jervis Public Library, Rome, NY

Letter to John B. Jervis from John Ledyarde, December 18, 1837, re: recommendation of Dennis McCool for employment as a mason
Jervis Public Library, Rome, NY

Letter, April 10, 1838: to John B. Jervis from H. Allen: "The object is, I believe, to make the men *feel* the want of work ..."
Jervis Public Library, Rome, NY

High Bridge During Construction of the Large Main, Viewed from the West Gate House, looking East, 1861 [2 versions]; **High Bridge During Construction of the Large Main, Viewed from the NY side of Harlem River, looking East**, 1861; **High Bridge, Additional Work to Cover the Large Main, Viewed from the West End of the Bridge Looking East**, 1862
From *Photographic Views of the High Bridge and the Gate Houses of the New Reservoir* (belonged to third Chief Engineer Alfred Wingate Craven); 20 1/8 x 28 1/4 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

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Harlem River Bridge/Isometrical View of Boom Derrick No. 2, c.1839
Ink and watercolor on paper; 33 x 24 inches
Jervis Public Library, Rome, NY, drawing #285

William Wade and William Croome, **Panorama of the Hudson River from New York to Waterford**
New York: D. Appleton & Company, 1847
The Hudson River Museum of Westchester, Gift of Michael Papantonio, 1968

The Aqueduct and Surrounding Neighborhoods, Yonkers, c.1890s
Contemporary print from original glass plate negative
The Hudson River Museum of Westchester

Section 6: Imagining the Aqueduct

J. F. Atwill, publisher, New York, **Croton Water Celebration** (City Hall Park), 1842. In pencil: "Astor House—Park Theatre/Croton Water Celebration, 1842"
Lithographed music title for "The Croton Ode"; 8 3/4 x 12 1/4 inches
The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2036

The Croton Ode, October 14, 1842. "Written at the request of the Corporation of the City of New York by George P. Morris, Esq."
Broadside poem; printed by Nesbitt; 13 3/8 x 5 1/8 inches
Museum of the City of New York, Gift of Walter I. Aims, 40.94

Commemorative Ribbon, 1842. "Completion of the Croton Aqueduct Celebrated New York, Oct. 14, 1842"
Ecru silk, printed; 7 5/8 x 3 13/16 inches
Museum of the City of New York, Gift of Constance Kilbourn, 38.117

Commemorative Medal, struck October 1842. "Croton Lake Reservoir, Available Capacity ... 114 ft. above tide ... Built be the City of New York ..." (front: Distributing Reservoir/reverse: section of Aqueduct)
Silver; 2 (dia.) X 1/2 inches
The J. Clarence Davies Collection, Museum of the City of New York, 34.100.217

Commemorative Medal, struck October 1842 (same design as above)
Base metal, red enamel paint; 2 (dia.) X 1/2 inches
The J. Clarence Davies Collection, Museum of the City of New York, 80.130.1

Invitation to John B. Jervis from Common Council, NYC, Celebration of the Introduction of the Croton Water Into the City of New York, 1842
Jervis Public Library, Rome, NY

F. Jones, **Thomas Dusenbury, Plumber, 269 Water St. New Peck Slip, N.Y. Croton Water**
Color lithograph advertisement; 16 1/16 x 11 1/4 inches
The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2484a

Alfred Hoffy (1790– ?), **Bostwick's Bottled Soda Water, Manufactory No. 105 Murray St. New York**, 1843
Color lithograph advertisement; 15 1/4 x 17 3/4 inches (image)
The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2488

Croton Brewery, Pale & Amber Ale, No. 59 Christie St. New York, n.d.
Colored lithograph; 13 3/8 x 19 5/8 inches
The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2951

C. Bachman, **New-York** (Croton water fountain and view to tip of Manhattan), 1849
Lithograph of Sarony & Major; published by John Bachman, NY
The Hudson River Museum of Westchester, 74.0.49

Sunday Excursion at High Bridge
Wood engraving from *Harper's Weekly*, Aug. 22, 1885; 14 x 9 inches
Courtesy of William Lee Frost

J. Bornet, **Croton** [Distributing] **Reservoir**, 1850
Colored lithograph; published by J. Hoff; 5 7/8 x 8 3/4 inches (ovoid image)
The J. Clarence Davies Collection, Museum of the City of New York, 29.100.2103

H. N. Tiemann, **Croton Aqueduct Distributing Reservoir**, 1899
Photograph; 9 5/16 x 6 3/16 inches
The Hudson River Museum of Westchester

Abstract of Corporation Ordinances and Rules adopted by the Croton Aqueduct Department, regulating the Use of Water, to which the attention of consumers and all others is earnestly invited, January 15, 1851
Courtesy of William Lee Frost

Table of Rates for the Use of Croton Water, 1850
Reproduction, courtesy of ESL Information Services, Engineering Societies' Library, New York, NY

Frank G. Johnson's Turbine Combination Water Metre, patented January 1, 1861. In *The Water Metre, and the Actual Measurement System of Charging for Public Water*, by Frank G. Johnson, M.D. (New York, 1862)
Reproduction, courtesy of ESL Information Services, Engineering Societies' Library, New York, NY

Scene at City Hall Pump
Wood engraving from *Frank Leslie's Illustrated Newspaper*, December 22, 1860; 4 3/4 x 9 1/4 inches
Cornelia Cotton Gallery

The Water Supply of New York
Wood engraving (tinted) from *Harper's Weekly*, May 28, 1881; 14 x 19 1/2 inches
Cornelia Cotton Gallery

Bacteria Found in Croton Water
Engraved illustration in Charles F. Gissler, *Contributions to the Fauna of the NY Croton Water Microscopical observations ... Drawings from Nature by the author's own hand, engraved on stone by F. Rixinger of NY*, 1870–71
Reproduction, courtesy of ESL Information Services, Engineering Societies' Library, New York

Map of the Croton Watershed: Sources of Impurities, 1878
In John Michels' *Croton Water, its Nature ... Properties and Impurities with Original Microscopical drawings of the Organic Deposit incl. Maps*, 1878
Reproduction, courtesy of ESL Information Services, Engineering Societies' Library, New York

Croton Water—What the People Drink/ Grant's Revolving & Self-Cleansing Filter ..., c.1879
Illustrated advertising pamphlet; 10 1/2 x 7 3/4 inches (folded)
Museum of the City of New York, Gift of Miss Grace Bingham, 39.297.9

Prof. S. Berendsohn's Rat, Roach & Bug-Killer, c.1864
Lithograph advertisement; printed by Charles Hart; 12 x 15 inches
Museum of the City of New York, Gift of Dr. Arthur Hunter, 56.153.13

The New Croton Dam, c.1890s
Contemporary print from original glass plate negative
The Hudson River Museum of Westchester

Gloeckner Newby Co., **New Croton Dam**, 1912
Photograph; 2 1/2 x 9 1/2 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

The New Aqueduct Passing under the Harlem River, NYC
Engraving (tinted) from *The Seven Wonders of the 19th Century*, vol. XXX, no. 29; 4 3/4 x 6 inches
Cornelia Cotton Gallery

Robert Havell, Jr., (1793–1878), **View of Croton Dam**
Engraved by Henry Jordan & Frederick Halpin (1805–1880); Frontispiece from Charles King's *A Memoir of the Construction, Costs and Capacity of the Croton Aqueduct, Compiled from Official Documents, Together with Account of the Civic Celebration of the 14th October, 1842* (New York, 1843)
The Hudson River Museum of Westchester, Gift of John Zukowsky

Possibly Frederick Styles Agate (1807–1844) or T. J. Carmichael, **View of the Single Arch and Whitson's Grist Mill**, c.1839
Oil on wood; 19 3/4 x 29 1/8 inches
Ossining Historical Society Museum, Gift of Melodia Wood Ferguson

Fayette B. Tower, **Croton Aqueduct at Yonkers,** From *Illustrations of the Croton Aqueduct*, 1843
Engraved by William James Bennett; 7 x 10 inches (image)
Ossining Historical Society Museum

Fayette B. Tower, **Croton Aqueduct at Clendinning** [sic] **Valley**
From *Illustrations of the Croton Aqueduct*, 1843
Engraved by William James Bennett; 5 1/2 x 10 inches (image)
Ossining Historical Society Museum

Fayette B. Tower, **Croton Aqueduct at Clendinning** [sic] **Valley**, c.1842
Ink on paper; 5 1/2 x 10 3/4 inches
Mrs. Helen Tower Wilson

Cornelia Drake Cobb, **Croton Aqueduct Bridge, Yonkers, NY**, 1899
Oil on canvas; 9 x 14 inches
The New-York Historical Society, New York,
Gift of Cornelia F. Muddiman and Anna E. Muddiman, 1959.90

Fayette B. Tower, **Croton Aqueduct at Haarlem River** (High Bridge), c.1842
Ink with watercolor wash on paper; 4 1/2 x 9 1/2 inches
Mrs. Helen Tower Wilson

William James Bennett (1789–1844), **Fishermen at High Bridge**, 1844
Watercolor on paper; 12 1/4 x 20 inches
Phelps Stokes Collection, Miriam and Ira D. Wallach Division of Art, Prints and Photographs, The New York Public Library, Astor, Lenox and Tilden Foundations

John William Hill (1812–1879), **High Bridge**, c.1848
Watercolor on paper; 20 3/4 x 31 7/8 inches
Richard York Gallery, New York, NY

David Johnson (1827–1908), **High Bridge**, c.1860
Oil on paper; 4 3/4 x 3 3/4 inches
Dana and Jeffrey Cooley

David Johnson, **Harlem River Aqueduct**, 1860
Oil on canvas; 7 3/4 x 13 inches
Private collection

Charles Henry Miller (1842–1922), **High Bridge from Harlem Lane**, 1873
Oil on canvas; 38 x 52 inches
Walter and Lucille Rubin

P. P. Pullie, **Tarrytown Curve, Old Croton Aqueduct**, 1905
Photograph; 7 1/2 x 9 1/2 inches
Collection of ESL Information Services, Engineering Societies' Library, New York, NY

Double Arch Viaduct, Ossining, N.Y., c.1910
Postcard, color print process from photograph. The Valentine & Sons' Publishing Co., Ltd., New York
Cornelia Cotton Gallery

J. Koehler, NY, **No. 1—The Promenade, Ossining, New York**, n.d.
Postcard, black and white print process from photograph. Published by Sands & Sherwood
Cornelia Cotton Gallery

Tilden Lovers' Walk, Yonkers, N.Y., postmarked 1910, **Greystone Lover's Walk, Yonkers, N.Y.**
Postcards, color print process from photographs
The Valentine & Sons' Publishing Co., Ltd., New York. Anthony Peluso

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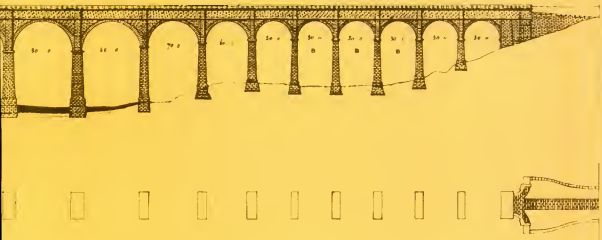

The Hudson River Museum of Westchester

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