Who Needs Engineers to Improve an Urban Water System? Lancaster's Bursting Reservoir Provided Plenty of Water

By Thomas R. Winpenny, Ph.D.

The 15,000,000 gallon reservoir that burst October 14, 1894, on the west side of town in Lancaster, Pennsylvania, raises a few important issues for modern scholars. First, there is a need to more carefully understand how growing urban areas in the 19th century met the soaring demand for water. Second, there is a desire to more fully understand technological failures and disasters of all varieties. Accordingly, this case study of a failed reservoir will examine the efforts of town fathers to provide the Red Rose City with water—fully realizing that any public works effort of this sort exists as a low priority with anemic funding in the city budget. This narrative will also endeavor to identify the technical expertise, and particularly the absence of expertise, that contributed to flooding the west side of Lancaster. It is assumed that sophisticated construction projects such as reservoirs are challenging even under ideal circumstances. In brief, tight-fisted town fathers were asking for trouble and they got it.

Water and the 19th-Century City

Nineteenth-century urban growth was driven primarily by industrialization together with the native- and foreign-born who sought employment in this emerging factory system. Rapidly expanding cities were hard pressed to both define the services a modern government should be responsible for and then provide them. Essentially, town fathers were expected to furnish police and fire protection, street lighting, street paving and cleaning, and a pure and

abundant supply of water for business, industry, and households. The location of slaughterhouses and restrictions on frame construction in the city's core represent a few of many additional considerations. To no one's surprise, urban governments struggled to meet even the most basic demands for services.

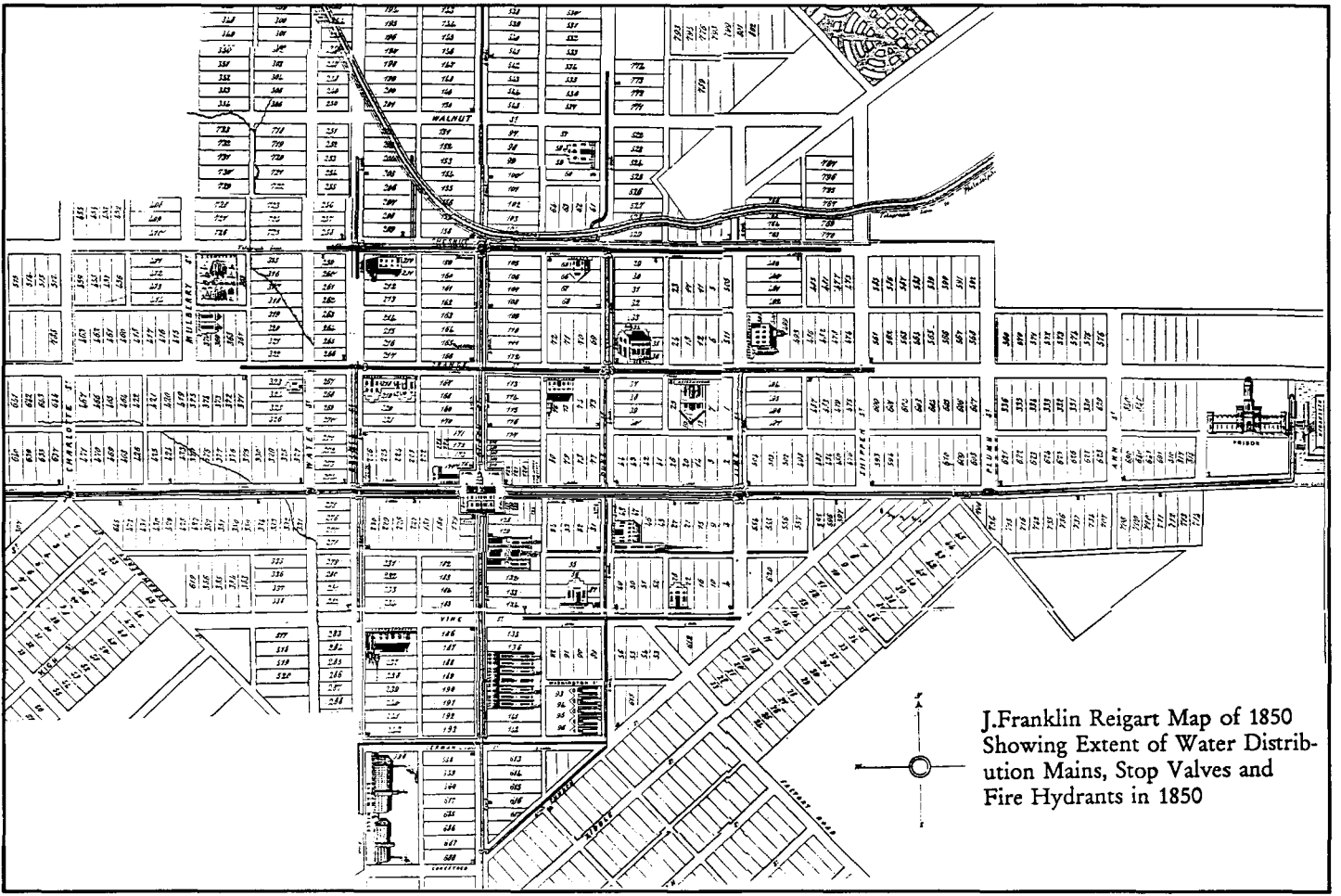
The water supply was critical far beyond the obvious conveniences of drinking, cooking, bathing, and flushing toilets. Town boosters and promoters knew it was vital to existing industry, and believed it was one key to attracting additional industry. More critically, physicians knew the importance of clean streets and pure drinking water in the conquest of cholera and in the ongoing struggle over typhoid. Consider the fact that in 1890-91 Lowell, Massachusetts, was ravaged by a typhoid epidemic that resulted in 132 deaths out of a population of 78,000 while Lawrence, Massachusetts, lost 74 out of a population of 47,000.[1] Over a more extended period (1894-1906), Pittsburgh lost over 5,000 each year to typhoid as the sewerage and industrial waste of neighboring communities contaminated the city's water supply.[2] Furthermore, in each setting it is reasonable to assume a far higher number of reported cases of typhoid than resulting deaths.

Lancaster was certainly threatened by typhoid—though perhaps to a lesser degree than the cities already cited. The Board of Health Report for February 1892 noted 28 cases of contagious and infectious typhoid and seven deaths. In June of 1894 there were 27 reported cases and five deaths.[3] (In each instance these monthly reports constituted the most severe results in their respective years.) In any event, the nexus between public health and water supply was painfully obvious.

Upgrading Lancaster's Water System

Lancaster's water needs to 1837 were met primarily by a variety of springs, wells, and pumps. On February 22, 1837, however, town fathers celebrated the opening of a "system" that pumped water from the nearby Conestoga River (just east of town) roughly a mile west to a 2,500,000 gallon reservoir on East King Street. Over the next few decades more and better pumps were added, and in 1851 a second reservoir was added to expand total reservoir capacity to 6,000,000 gallons.[4] Apparently this system left some denizens of the Red Rose City completely unimpressed and thus the Minutes of the City's Select Council for July 7, 1875 observe: "intelligent citizens want to move water by natural flow from streams at high elevation—rather than by artificial means by pumping the water."[5] This insight that water does not run uphill is, perhaps, the first major indication of Lancastrians looking to a major reservoir at the elevated or west end of town.

The size and scope of Lancaster's water system is hinted at in a June 6, 1877, entry in the Select Council Minutes where it is reported that last year, "1,470 feet of pipe for water mains laid, five stop valves and five fire plugs



J.Franklin Reigart Map of 1850 Showing Extent of Water Distribution Mains, Stop Valves and Fire Hydrants in 1850

have been set and 106 permits for using city water have been issued."[6] The system was enhanced in May of 1878 with the erection of "one compound duplex pump" having a capacity of 3,000,000 gallons per day.[7]

The ensuing decade, or the 1880s, appears to have been one in which the city pumped an extraordinary supply of water to customers who did a world-class job of wasting it. (At least one stand pipe was erected on the west side in the 1880s to supplement supply.) One wild estimate argued Lancastrians consumed 190 gallons per person per day—far in excess of consumption in America's leading cities: Wilmington, Delaware, 105; Philadelphia, 100; New York, 75; and San Francisco, 62.[8] The alleged cure for this excess was the installation of meters and house-to-house inspection in early 1889.

Average Daily Consumption of Water in Lancaster

Year	Population	Total (Gallons)	Per Capita (Gallons)
1880	25,670	2,040,311	80
1883	27,395*	3,010,578	110
1886	29,120*	3,785,323	130
1888	30,270*	4,422,218	146
1890	31,420	4,318,410	137
1891	32,000*	5,072,010	159

* = Estimated

Source: Charles B. Brush, C.E., *Report to Mayor and Special Committee, Lancaster, Pennsylvania, on Lancaster Water Works and Improvement of Water Supply, May 4, 1891.*

The aforementioned data do indicate that the measures taken in early 1889 provided some temporary respite in the rising per capita consumption, and yet by 1891 this figure is rising again. Given the apparent inability of metering and house-to-house inspection to halt the rise in daily per capita consumption, the obvious remaining "culprit" is industrial use.

In light of this rising consumption a Special Report of the Water Committee to Select Council, July 6, 1890, suggested a new reservoir "on high ground west of Franklin and Marshall College" with a capacity of at least 40,000,000 gallons to supplement the current reservoir's modest capacity of 5,500,000 gallons—just in excess of a one day's supply.[9] It was estimated that this reservoir and a 36-inch connecting main would cost approximately $275,000, and that rising city water receipts would allow this to be done without a tax increase.[10]

The Brush Report

Perhaps the proposal for a 40,000,000 gallon reservoir was not realistic, but roughly one year beyond that suggestion a new report by Charles B. Brush, C.E., to Mayor Robert Clark included ideas that would be acted upon. The new plan called for purchasing a 22.5 acre tract with elevations ranging from 430 feet to 404 feet above tide water, located directly behind the original buildings at Franklin and Marshall. This parcel of land known as the Sweatman (or Suitman) tract was to be purchased for $20,250, or just less than $1,000 per acre.[11] Consulting Engineer Brush looked at two other tracts on the west side of town, and tested the soil at all three sites. On all three tracts he found eight inches of top soil covering 2-3 feet of clay, and beneath the clay some sand and "disintegrated material with some indications of rock."[12] His evaluation of the clay led him to conclude, "The best of the clay is not entirely satisfactory"[13] as it was made up of 65 percent clay and 35 percent sand and siliceous material. "The sand is rather fine, and the clay when thrown out on the bank does not present the lumpy appearance found in clay of better quality."[14] Brush admitted the clay needed additional examination, but no doubt feared the predisposition of the water committee or the contractor to simply use whatever was available "on site."

Brush's general conclusion, however, was that it is "entirely practicable to build a 15-million gallon reservoir on the Sweatman tract with the flow line at an elevation of 445 feet with a water depth of 25 feet."[15] He estimated that 91,000 cubic yards of embankment would be required and that roughly a third of this could be garnered within the lines of the reservoir.[16] The cost of this project—not including pipes or rock excavation—was to be between $87,500 and $100,000, the higher figure being required if the lining of clay puddle had to be found beyond the property and transported to the site.[17]

Implementing the Plan

On June 11, 1892, Lancaster's Select Council authorized the Special Committee on Reservoir and Water Supply to both borrow $150,000 and to purchase the 22.5 acre site for $20,500. Contracts were awarded to Samuel Wilson Frescoln of Frescoln and Rooney for construction of the reservoir for $64,000, and to Henry R. Worthington of New York for a 10 million gallon high density pumping engine.[18] Charles B. Brush of New York City served as consulting engineer to this point, but was deemed too expensive to continue. He was replaced by city regulator Allen A. Herr and an assistant—paid a total of $200 per month. Work probably started late in 1892 and continued through 1893 and 1894. One of the first "official inspections" by a committee of Lancaster's Select and Common Councils—in an age when such inspections might include a pompous march by the participants from City Hall to the work site—took place on May 8, 1894, when a considerable part of three sides and the bottom

had been "paved and concreted."[19] The committee expressed concern that the bottom of the reservoir was not sufficiently hard and had to be reassured it would harden over time.

Visits by the Special Water Committee on May 29 and 31, 1894, generated questions about the cement work. While Mr. Frantz and Mr. Erisman thought everything was fine, Mayor Smeltz speculated that the cement had been improperly mixed (so soft it could be penetrated by a knife.) Mr. Riddle went one step further and asserted Frescoln was saving "several thousand dollars by using other than Portland cement."[20] Specifications called for a high quality of Portland cement, except on the bottom.) The newspaper account of this inspection visit concluded with a grim observation: "From present indications much will have to be done by the city at a considerable expense even after the contractors are through. ..."[21]

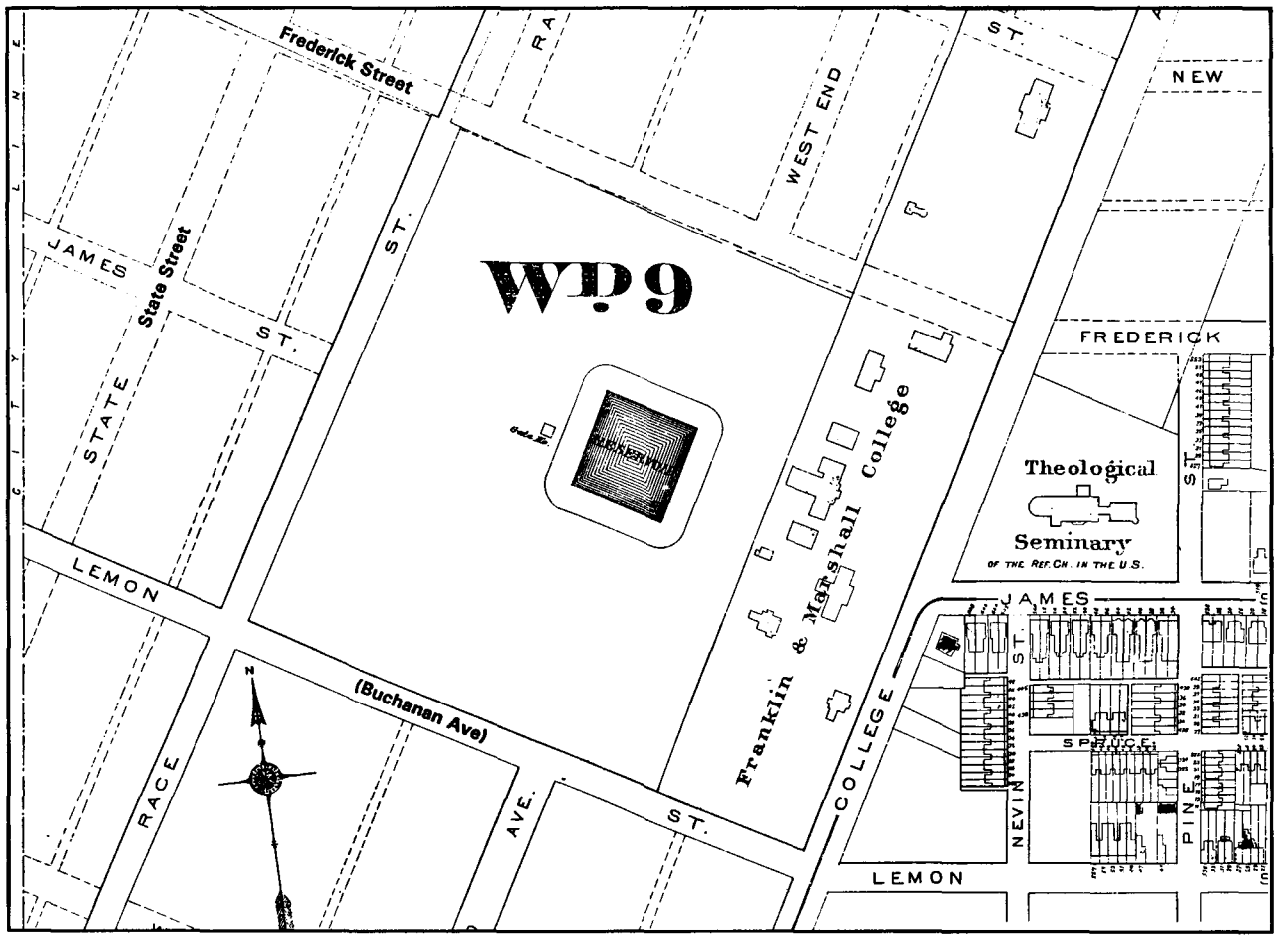
Three weeks later the big man from the big city visited Lancaster and delivered a mixed message. Charles Brush reassured the citizenry by asserting, "Lancaster will have a perfectly tight reservoir"—and then went on to express concerns and reservations. He believed the cement used contained entirely too much sand, but added that, "cement and brick linings are not essential to make the reservoir watertight."[22] Brush did not like the idea of the lining for the sides being applied on two inches of concrete, and denounced this as a "Philadelphia idea" that is utilized almost nowhere else. In essence, however, he held to the idea that the quality of backing and puddle constituted the key to watertightness. As a footnote to all of this, he said the city was justified in ripping out a brick bottom that failed to meet specifications.[23] For the next 3½ months the citizens of the Red Rose City heard little or nothing about the progress of the reservoir until the time came, in mid-October, to fill and test the new facility.

Busted!

At 10 o'clock on Sunday evening October 14, 1894, Superintendent Davis Kitch and his assistant Frederick Heims were in the gate house adjacent to the reservoir when they heard a rumbling that signaled the breaking of the west bank—a split second later, "the bank washed away in a torrent."[24] Kitch and Heims ran to the northwest corner of the reservoir and called to construction workers, housed in nearby shanties and barracks, "run for your lives."[25] Most got out before the 10,000,000 gallons of water hit.

The water stormed westward toward Race Street (away from the Franklin and Marshall campus), hit a bank of clay and was diverted north and south, resulting in the flooding of the Kauffman, McVoy, and Hamilton properties. The water cut 5-6 foot gutters in the soil and sent water pipes flying. Kitch reached the pumping station by phone and had the pumps shut down, thereby bringing the immediate crisis to a halt.

Let the record show that the new structure had not failed at capacity, but



Site of the doomed reservoir located west of the Franklin & Marshall College campus. (*Atlas of Surveys of the County of Lancaster,* Graves & Steinbarger, 1899)

rather at two-thirds capacity, or 10,000,000 gallons, or 21 feet. The water had been introduced to the facility over the preceding ten days with the intention of completing the process in a total of fourteen days.[26] The bursting of the western wall left a thirty-foot gap in the western embankment from top to bottom. In addition, there was a break at the southwest corner of the structure and a break at the southeast corner some sixty feet in length, suggesting that if the western wall hadn't burst, the eastern wall would have. The combination of damage done together with the perceived quality of the structure guaranteed that this facility would never serve as a reservoir. In brief, property had been damaged, lives had been threatened, and an investment had been lost. It was now time for a world-class tournament of finger pointing in order to establish blame.

The Other Guy Did It

The "morning after," or Monday, October 15, the Special Water Committee went to examine the break and failed to find "good clay puddle for filling" and thus considered removing the brick lining and reconstructing the entire interior. Instead of clay puddle (called for in the specs), they found "shale, mica, loam, and common earth."[27] Who was actually responsible for this? Incidentally, since Frescoln and Rooney had to turn over a watertight reservoir to the city, and had not yet done so, they were still "on the hook"—contractually.

The *Morning News* on Tuesday, October 16 editorialized that Charles Brush was coming in from New York today, and he better have some "answers" to justify all the money he had been paid![28] Ironically, the city had determined they could not afford Brush or anyone comparable once the construction got underway; at least on site.

Brush spent Tuesday in Lancaster, but didn't clear up as much as some had hoped. He argued, "the clay puddle was good, the concreting was first class, the crack in the southeast side was not worthy of notice. ..."[29] Brush agreed the foundation was miserable, and wanted to know why inspector Kitch had not held the contractor to specs. Inspector Kitch claimed he had ordered the contractor to stop work on several occasions when it did not meet specifications. Contractor Frescoln argued, in essence, that there were far too many bosses, supervisors, and inspectors hovering over the project, and thus he could be "wrong in following Kitch, and yet wrong if he didn't."[30] City Solicitor Snyder charged both Frescoln and Kitch with changing specs without proper authority. That is, Frescoln did as he pleased and Kitch approved the work.

Frescoln's position was buttressed when he more specifically identified the legion of "authorities" associated with the reservoir construction:

Three different Special Water Committees;
Three different Select and Common Councils;

Three different Finance Committees;
Two Mayors holding opposite views;
Two Consulting Engineers;
Four Resident Engineers;
Three Inspectors; and
Two City Solicitors.

Perhaps the contractor was overstating his case when he claimed to have roughly 150 bosses over a few years, but his basic point was well taken.[31]

On October 24, however, the *Morning News* offered the opinion that Frescoln had decided to "pose as a martyr."[32] The contractor noted that the water had been put into the new structure without his accord; and, furthermore, far too much was put in far too rapidly. Frescoln contended that a limited quantity should have been introduced—allowing an opportunity to test the structure for defects. He further complained that it was hard to work with a consulting engineer who was 200 miles away, the city owed him money, and "if I do more work, I'll have to be paid."[33]

Thus, as the story unfolds it becomes clear that no one is responsible for the disaster. Everyone is adept at pointing the finger at someone else. Discussions are held to determine how the damaged reservoir will be repaired and who will pay for the repair. In the end, however, it is determined that the existing structure is worthless and a menace to citizens and thus will not be rebuilt.

Who Is Really At Fault?

Assigning blame is rarely a simple matter, and surely there is no totally disinterested party in this episode. Having said this, the author believes that the most useful analysis was provided by a professional engineering journal that showed considerable interest in the Lancaster story.

On October 20, 1894, the *Engineering News and Record* announced that the Lancaster break was "typical of one kind of municipal foolishness."[34] The city had endeavored to construct a reservoir resting on "very porous rock composed of slate, limestone, calcite, rotten shale, etc. ... full of seams, open pockets—some large enough to hold a man or a horse."[35] The engineer instructed the contractor to fill these pockets with broken stone, "excavate another foot and pour two courses of concrete—about a foot."[36] Sounds good, but without an engineer on site alternative "leadership" surfaced. For example, in one instance a local mason took charge and constructed "a brick collar around the outlet pipes."[37] While this obviously made sense to the mason, the brick collar broke the puddle lining.

Why wasn't there an engineer on site? Primarily because the city fathers pursued a common "penny-wise and pound-foolish policy."[38] The city assumed it could not afford Brush, and yet had to bring him back during the second

half of 1893. A new economy government dismissed Brush early in 1894, but once again he had to be brought back in June of 1894.[39] In essence, the Red Rose City could only afford the consulting engineer in an emergency, and by then it was too late.

The *Engineering News and Record* concluded that it was wrong-headed for the city to hold the contractor liable for not adhering to specifications when the city inspector compelled him to deviate. In short, "It would be manifestly unjust to compel the contractor to assume the loss which such a mistake caused."[40]

Conclusion

It is a truism that no nineteenth-century American city could hope to grow and somehow ignore the demand for additional water. A pure and abundant supply of water was required to meet the expectations of residents, businesses, industries, and guardians of public health. A 15,000,000 gallon reservoir on the west side of Lancaster in the mid-1890s was an entirely sensible solution. Unfortunately, this episode ultimately served as a reminder that some public works projects are too sophisticated to be managed by an everchanging cast of municipal authorities—each group a bit more tight-fisted than the one before!

Endnotes

1. Stuart Galishoff, "Triumph and Failure: The American Response to the Urban Water Supply System, 1860-1923," in Martin Melosi, ed., *Pollution and Reform in American Cities, 1870-1930,* (Austin: University of Texas Press, 1980), 39 and 40.

2. Ibid.

3. See *Board of Health Reports, 1892-1894, Lancaster, Pennsylvania,* in Lancaster County Historical Society.

4. For a discussion of Lancaster's early water system see M. Luther Heisey, "The Water Supply of Lancaster," *Journal of the Lancaster County Historical Society,* XLI, No. 1, (1937): 1-24.

5. *Select Council Minutes,* July 7, 1875, Lancaster, Pennsylvania, in Lancaster County Historical Society.

6. Ibid., June 6, 1877.

7. Ibid., May 25, 1878.

8. Ibid., circa July, 1890, remarks by Mr. Riddle.

9. *Special Report of the Water Committee to Select Council,* July 6, 1890, Lancaster, Pennsylvania.

10. Ibid.

11. Report by Charles B. Brush, C.E., to Mayor Robert Clark of Lancaster, circa August, 1891.

12. Ibid., 9.

13. Ibid.
14. Ibid.
15. Ibid.
16. Ibid., 12.
17. Ibid., 13.
18. *Select Council Minutes,* June 11, 1892.
19. *Lancaster Morning News,* May 9, 1894, 1.
20. Ibid., May 30 and June 1, 1894, 1.
21. Ibid., June 1, 1894, 1.
22. Ibid., June 22, 1894, 1.
23. Ibid.
24. Ibid., October 15, 1894, 1.
25. Ibid.
26. Ibid.
27. Ibid., October 16, 1894, 1.
28. Ibid.
29. Charles B. Brush quoted in the *Morning News,* October 17, 1894, 1.
30. Samuel W. Frescoln quoted in the *Morning News,* October 17, 1894, 1.
31. Ibid., October 24, 1894, 1.
32. *Morning News,* October 24, 1894, 1.
33. Ibid.
34. *Engineering News and Record,* October 20, 1894. (A leading professional journal highly regarded by civil engineers.)
35. Ibid.
36. Ibid.
37. Ibid.
38. Ibid.
39. Ibid.
40. Ibid.

Dr. Thomas R. Winpenny, an LCHS trustee, Hagley Fellow, and professor of history at Elizabethtown College, has authored numberous articles on industrial history.