BIC CONESTOCA CREEK BRIDCE No. 12
Pennsylvania Historic Bridges Recording Project - II
Spanning Conestoga River at Farmersville Rd. (State Rt. 1010)
Brownstown vic.
Lancaster County
Pennsylvania

HAER No. PA-500

PHOTOCRAPHS

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HISTORIC AMERICAN ENGINEERING RECORD

BIG CONESTOGA CREEK BRIDGE No. 12

HAER No. PA-500

Location:	Spanning Conestoga River at Farmersville Rd. (State Rt. 1010), Brownstown vicinity, Lancaster County, Pennsylvania.
USGS Quadrangle:	Ephrata, Pennsylvania (7.5-minute series, 1974).
UTM Coordinates:	18/397725/4442420
Date of Construction:	1917.
Designer:	Frank H. Shaw (Lancaster County Engineer).
Builder:	Paul D. Kauffman (contractor, Reading, Pennsylvania).
Present Owner:	Pennsylvania Department of Transportation.
Present Use:	Vehicular bridge.
Significance:	Big Conestoga Creek Bridge No. 12 is a rare combination of cantilever, arch, and through-girder forms in reinforced concrete. Lancaster County engineer Frank H. Shaw, designing to meet economic constraints, site conditions, and political pressure, crafted this unusual solution in a short window of opportunity before the advent of state standards for reinforced concrete bridges. Its main span of 62'-5" is flanked by two 31'-0" cantilever arms whose tips do not rest upon the concrete abutments, which probably enclose stone abutments from a previous bridge. Of six similar structures designed by Shaw, this is one of two which remain in the state highway system. This bridge was listed on the National Register of Historic Places in 1988.
Historian:	Justin M. Spivey, August 1998.
Project Description:	The Pennsylvania Historic Bridges Recording Project - II was co-sponsored during the summer of 1998 by HABS/HAER under the general direction of E. Blaine Cliver, Chief; the Pennsylvania Department of Transportation, Bureau of Environmental Quality, Wayne W. Kober, Director; and the Pennsylvania Historical and Museum Commission, Brent D. Glass, Executive Director and

State Historic Preservation Officer. The fieldwork, measured drawings, historical reports and photographs were prepared under the direction of Eric DeLony, Chief of HAER.

Introduction

Even after the establishment of a state highway system in 1911, Pennsylvania counties continued to construct and maintain less-traveled local roads.[1] In Lancaster County, before and after the advent of state highway aid, townships would petition the county government to undertake the expense of bridge construction. The Commissioners' Court appointed three viewers to determine whether the bridge was needed; after it was constructed, three inspectors were sent to accept it.

Frank H. Shaw, born in Weymouth Landing, Massachusetts, moved to Lancaster around 1905 and set up practice as a civil engineer.[2] In 1908, he served as an inspector for Lancaster County's first reinforced concrete bridge, a closed-spandrel arch constructed by the Ferro-Concrete Company of Harrisburg.[3] Shaw, already working to improve the city of Lancaster's water and sewer systems, must have convinced the Lancaster County commissioners of the need for his services shortly thereafter. The next year, he was appointed county engineer by the Commissioners' Court, with an annual salary of $480.00.[4] According to the current county engineer, Robert Navitski, the position was then on a part-time consulting basis.[5] Nonetheless, Shaw would soon lead the county on a bridge-building campaign, for which he designed at least forty reinforced concrete structures as county engineer until 1917 and consulting engineer thereafter. Shaw's most interesting Lancaster bridges (see Appendix A) include two concrete trusses, both of which survive today, and half a dozen cantilevered through girder bridges, of which two remain. One of the latter spans the Conestoga River (formerly Big Conestoga Creek) on the road between Brownstown and Farmersville in West Earl Township.

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[1] See Haven Hawley's more comprehensive discussion of the state highway system in U.S. Department of the Interior, Historic American Engineering Record (HAER) No. PA-486, "South Branch Conewago Creek Bridge," 1998, Prints and Photographs Division, Library of Congress, Washington, D.C.

[2] "Frank H. Shaw is Dead at 78," obituary in *Lancaster New Era,* 15 May 1950; R. L. Polk, *Lancaster City Directory* (Lancaster, Pennsylvania: R. L. Polk & Co., 1905).

[3] Lancaster County, Bridge Minutes 1874-1934, 6 June 1908, Lancaster County Archives, Lancaster, Pa.; Lancaster County, Bridge Docket, Lancaster County Engineer's Office, Lancaster, Pa. The 1908 bridge, Hammer Creek No. 1 in Lancaster County, Bridge Docket, is also listed in the National Register of Historic Places; see "Three Distinctive County Bridges Named to Historic Register," *Lancaster New Era,* 15 August 1988.

[4] Lancaster County, Commissioners' Court Minutes 1916-1920, 5 April 1909, Lancaster County Archives, Lancaster, Pa.

[5] Robert Navitski, Lancaster County engineer, conversation with author, 23 July 1998.

Lancaster County

The area now within Lancaster County was first settled in 1691. In 1729, the county was created from part of Chester County and named for Lancashire, England. Seventeen original townships included Earl Township, which was divided into West Earl, Earl, and East Earl in 1833. Because of the county's early settlement and prominent role in Pennsylvania politics (including the county seat's brief service as state capital), its history is well-documented. The general history in this section was culled from H. M. J. Klein's 1924 *Lancaster County, Pennsylvania: A History,* to which the reader is referred for greater detail.[6]

Lancaster County's topography of rolling hills is marked by a large number of streams and rivers. Lancastrians used the abundant water power for milling, with the first recorded mill on Chickies Creek in 1719.[7] According to Klein, German settler Hans Graaf was the first to arrive in the area of West Earl Township, in 1717.[8] The Wenger family arrived from Germany a decade later and constructed a wooden mill on Big Conestoga Creek. It was replaced by a stone structure and purchased by John Wolf in 1811.[9] The mill at this site attracted farmers from both sides of the river, popularizing a river crossing at that location. As towns grew up around nearby crossroads, the ford eventually evolved into a bridge.

Rapid population growth in the nineteenth century made the streams and rivers obstacles to land-based transportation. The ford at Wolf's mill was no exception. With the establishment of Farmersville in 1843 and Brownstown in 1845, it became the most direct route between them.[10] Indeed, Lancaster's entire network of small towns and connecting roads required a large number of all-weather crossings. This need was answered quickly and economically by wooden bridges. Such a flurry of covered bridge construction resulted that, as late as 1931, Lancaster County still had 175 in service.[11]

The Bridge at Joel Wenger's Mill

Citizens of West Earl Township first voiced the desire for a bridge across Big Conestoga Creek to the Lancaster County commissioners in January 1841. The county road docket records

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[6] H. M. J. Klein, *Lancaster County, Pennsylvania: A History* (New York: Lewis Historical Publishing Co., 1924).

[7] Mary H. Yeager, "Historic Bridge-Building in Lancaster County," *Journal of the Lancaster County Historical Society* 41, No. 6 (1937): 135.

[8] Klein, *Lancaster County,* 16, 131.

[9] R. Harold Barton, "Mills and Bridges of Lancaster County," No. 173, typescript, n.d., manuscript group 16, Lancaster County Historical Society, Lancaster, Pa.

[10] Klein, *Lancaster County,* 143-4.

[11] Yeager, "Historic Bridge-Building," 133.

their petition, "Ford there being frequently rendered impassable by means of Ice and High Waters," and the appointment of six viewers.[12] No action was taken, and viewers were appointed again three years later. The viewers' report, filed 27 April 1844, but not approved until November 21, was in favor of a bridge.[13] These delays seem to reflect the general reluctance of a county government swamped with requests for new bridges.

A wooden covered Burr arch-truss bridge, 13 feet wide and spanning 130 feet, was constructed by Elliott and Russell in 1845 for $1299.00.[14] The bridge had horizontal clapboard walls and a simple gable-end portal with vertical board-and-batten siding. Inspectors appointed by the commissioners filed their report on September 16 of that year, approving the bridge and even recommending an additional payment of $35.00 because the contractor "built extra necessary walls".[15] Repairs were required in only three recorded instances, totaling $580.03, during its 72 years of service.[16] The covered bridge was replaced in 1917 by the present concrete structure.

As were many of Lancaster's covered bridges, the first bridge on Farmersville Road was named for the mill that stood nearby. In 1863, the Wenger family resumed possession of the site, when Joel Wenger purchased the five-story stone mill built eight years earlier by Jacob Wolf.[17] Therefore the wooden bridge appears in Lancaster County records as "the bridge at Joel Wenger's mill." The mill, owned by the family until 1923, was converted to generate electricity in 1903 by Clayton Wenger.[18] His power plant is featured in a 1924 description of Brownstown: "... a banking town of 500 population, has an electric light, heat, and power plant, a knitting mill, a flouring mill, about half a dozen cigar factories, a printery, two hotels, a lumber yard...."[19] The location was still defined by the mill in 1917 when

> The County Commissioners proceeded to Wenger's Mill at Brownstown, for the purpose of disposing at Public Sale, the lumber of Old County Bridge No. 12 over Conestoga Creek, which was torn down and replaced by a New Concrete Bridge.[20]

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[12] Lancaster County, Road Docket, 15:460-1, Lancaster County Archives, Lancaster, Pa.

[13] Lancaster County, Road Docket, 16:176-7. Lancaster County, Bridge Docket, gives a different filing date: 20 August 1844.

[14] Lancaster County, County Buildings and Bridges, 91, Lancaster County Archives, Lancaster, Pa.

[15] Lancaster County, Road Docket, 16:318.

[16] Lancaster County, Bridge Docket, 127.

[17] Barton, "Mills and Bridges," No. 173.

[18] Alice W. Weaver, "The Original 'Brownstown Mill,' 1856," *Lancaster Magazine* (May 1977): 12.

[19] Klein, *Lancaster County,* 144.

[20] Lancaster County, Commissioners' Court Minutes 1916-1920, 25 July 1917.

A Concrete Bridge

Lancaster County began replacing its wooden covered bridges with reinforced concrete spans in 1908, when the Ferro-Concrete Company built a closed-spandrel arch over Hammer Creek, perhaps as a demonstration project. Bridge replacement was occurring throughout the United States in response to increasing automobile traffic. National trends supplemented local pressure to sway the Lancaster County commissioners in favor of upgrading many of its wooden covered crossings. The American Automobile Association's Lancaster chapter, which had its own magazine and pressed lawsuits against turnpike companies, must have been a particularly strong local advocate.[21] Its magazine, *Lancaster Motorist,* praised the county and state when they built new roads and bridges, and upbraided them when improvement projects were delayed. The county replaced more than one a year between 1915 and 1920; this figure does not include construction sponsored by the state.[22]

Bids were opened for Big Conestoga Creek Bridge No. 12 and Cocalico Creek Bridge No. 5 on 22 March 1917. Paul D. Kauffman of Reading was the lowest of seven bidders at $7405.56.[23] Other bidders include the Ferro-Concrete Company of Harrisburg, which built Lancaster County's first concrete bridge, J. M. Eshleman, and Paul Sherich; the latter two constructed a number of bridges designed by Shaw. The Farmersville Road bridge took only three and a half months to construct. Inspectors H. E. Kennedy, Landis Levan, and Richard Blickendorfer were appointed on 7 July 1917, and filed their favorable report three weeks later.[24]

Paul D. Kauffman may have launched his contracting career with the bridge at Farmersville Road. He is listed in city directories as "student" from 1905 until 1909, when his occupation changes to "civil engineer."[25] None of the five Berks County colleges currently offers a civil engineering degree, but Kauffman may have been studying via a correspondence course. He did not advertise in the directory, so it seems likely that he was working for someone else, perhaps an engineering or contracting firm. He began bidding on concrete bridges under his own name in Lancaster County in 1917, Big Conestoga No. 12 being his first. While constructing two similar three-span cantilever bridges, one just over a mile downstream on the Conestoga and another over Cocalico Creek, he ceased bidding for several months.

Kauffman's last recorded bid in Lancaster County was the high bid on Pequea Creek Bridge No. 14, in April 1918.[26] Either his pricing was no longer competitive or business

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[21] "Proceedings Against Marietta Turnpike Company," *Lancaster Motorist* 3, No. 11 (August 1915).

[22] Yeager, "Historic Bridge-Building," 133.

[23] Lancaster County, Commissioners' Court Minutes 1916-1920, 22 March 1917.

[24] Lancaster County, Bridge Minutes 1874-1934, 91.

[25] W. H. Boyd, *Reading City Directory* (Reading, Pa.: W. H. Boyd Co., 1905-29).

[26] Lancaster County, Commissioners' Court Minutes 1916-1920, 29 April 1918.

elsewhere distracted him. *Historic Highway Bridges of Pennsylvania* credits "Paul Kaufman" (one "f") with the design of the Second Street Bridge, an 84'-long Marsh-type concrete arch in Chester.[27] Assuming this is a misspelling, Kauffman was building bridges as far east as Delaware County. In 1919, his occupation changed again to "contractor"; he is listed as such in city directories for two years thereafter.[28] Kauffman then disappeared from Reading until 1927, and returned as president of Reiffton Development Corporation. Advertised as "The Smokeless Suburb," Reiffton was an early subdivision east of Reading on U.S. Route 422. Kauffman and the Reiffton Development Corporation disappeared from city directories after 1929, evidently ruined by the stock market crash.

Frank H. Shaw

The designer of Big Conestoga Creek Bridge No. 12, Frank H. Shaw, moved from New England to Lancaster around 1905. He advertised his engineering firm in county directories, and also in promotional literature published by the Lancaster Board of Trade, of which he was a member.[29] The latter contains images of Lancaster's Water Street sewer under construction and the water tower, now in the middle of Franklin and Marshall College's campus, with a Gothic spire. These improvements predate Shaw's tenure as superintendent of the water works from 1911 to 1913, so he probably designed them on a consulting basis.[30] Shaw's obituary lists yet more accomplishments:

> He designed the Clay St. and Water St. sewer lines in Lancaster. Shaw rebuilt the water system of Elmira, N.Y., and did much of the work on the water system in Reading. His engineers laid out many of the street railway lines in eastern cities.

The death notice reminded readers that "the first concrete bridges ever built in Lancaster bear his name as the engineer."[31]

Shaw's work extended far beyond Lancaster and kept him constantly on the move. Not only did his residence change frequently within Lancaster, but city directories also list his home in East Orange, New Jersey (1919-20); Houston, Texas (1923-24); and Washington, D.C.

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[27] Pennsylvania Department of Transportation, *Historic Highway Bridges of Pennsylvania* (Harrisburg: Pennsylvania Department of Transportation, 1986), 173.

[28] Boyd, *Reading City Directory* (Reading, Pa.: W. H. Boyd Co., 1919-21).

[29] William S. Rhode, *Rhode's Lancaster County, Pennsylvania, Directory* (Kutztown, Pa.: William S. Rhode & Co., 1921), 742; Richard M. Reilly, ed., *City of Lancaster* (Lancaster, Pa.: Lancaster Board of Trade, 1909), 49.

[30] M. Luther Heisey, "The Water Supply of Lancaster," *Journal of the Lancaster County Historical Society* 41, No. 1 (1937), 24.

[31] "Frank H. Shaw is Dead at 78," obituary in Lancaster *New Era,* 15 May 1950.

(1935).[32] The New Jersey residence may be explained by Shaw's second office, at 56 Pine Street in New York City.[33] Shaw was evidently willing to travel where his expertise was needed; further research may connect him with engineering projects in Houston and Washington. One of Shaw's associates listed in the directory advertisements, S. Z. Studenroth, eventually became county engineer; however, Shaw's name still appears on drawings for concrete bridges during Studenroth's tenure.

In a 1909 Board of Trade publication, Shaw describes himself as "making a specialty of reinforced concrete work," an advertisement coinciding with the start of his concrete bridge-building campaign. Yet the earliest concrete bridges in Lancaster may have been designed by another Shaw: his brother Percy. A 1911 article in *Engineering Record,* written by Percy A. Shaw, describes a concrete through-girder bridge at Rupps Mill.[34] Percy's by-line reads "Designing Engineer, Reading, Pa.," and he worked with his brother Frank in Lancaster in 1913.[35] Frank divided his attention between the offices of county engineer and superintendent of water works during this time, so Percy evidently designed his brother's bridges. The *Engineering Record* article credits Frank with merely supervising the bridge's construction.[36] At any rate, Frank was designing bridges single-handedly in 1917 (though perhaps borrowing from his brother's designs), when the bridge was constructed at Farmersville Road.

Description

On its westward course toward the Susquehanna, the Conestoga River makes an S-shaped bend east of Brownstown. The river flows south, then north, then south again past Brownstown. Near the apex of the last bend, the Conestoga passes over a dam which formerly fed water into a millrace on the river's east bank. Brownstown's Main Street heads east toward the Conestoga, parallels the river on its west bank up to the dam, then bends northward toward Akron. About 1500 feet downstream from the dam, Farmersville Road branches off Main Street, and crosses the Conestoga River on a reinforced concrete bridge of three spans. The bridge is on an east-west alignment, perpendicular to the river, but the road bends considerably as it continues eastward toward Farmersville.

At the eastern end of the bridge is a concrete box culvert spanning the former millrace. The millrace bridge spans eighteen feet, starting about a hundred feet from the river span's

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[32] R. L. Polk, *Lancaster City Directory* (Lancaster, Pa.: R. L. Polk & Co., various years).

[33] Rhode, *Rhode's Lancaster County,* 742.

[34] Percy A. Shaw, "A Reinforced Concrete Through Girder Bridge," *Engineering Record,* 64, No. 26 (23 December 1911): 744-5. This bridge is Big Conestoga Creek No. 11 in Lancaster County, Bridge Docket.

[35] Polk, *Lancaster City Directory* (Lancaster, Pa.: R. L. Polk & Co., 1913).

[36] Shaw, "A Reinforced Concrete Through Girder Bridge," 745.

eastern end. A plaque on the smaller bridge's one remaining (south) parapet indicates that it was built by West Earl Township in 1907 and designed by C. S. Wenger.[37]

Big Conestoga No. 12's structural form is best described as a cantilevered through girder, although some arch action exists in the middle span of 62'-5".[38] The identical outer spans, measuring 31'-0" each, cantilever out from the two 3'-0"-wide piers and do not rest on the abutments. Adding these figures gives a total span length of 130'-5". Due to a small expansion gap at either end of the span, the distance between abutment faces is slightly longer. The roadway is 18'-0" wide, with 1'-9" parapet walls to either side, for a total width of 21'-6". "One Lane Bridge" signs at either end confirm that the bridge is too narrow for two-way traffic.

A bronze plaque inside the north parapet wall lists the county commissioners, engineer, contractor, "SAFE LOAD -20- TONS," and the year of construction.[39] Currently, the bridge is not posted with a weight limit, and carries mostly farm traffic with the occasional truck. Despite its inadequate width and some concrete spalling on its underside, the bridge at Farmersville Road still serves as its designer intended. A 1987 inspection report sums it up, "Overall good condition too bad it's narrow."[40]

Four arcs shape the bridge's profile: three arch barrels are collected under a vertically curved parapet whose arc runs the full span length. The middle arch is relatively flat, rising less than 4 feet over its 62'-5" length, and the outer two arches are essentially halves of the middle. All three arches have smooth barrels without ribs or decorative features. The crown of the middle arch is 15'-0" above the water line. The curving parapet wall behaves as a continuous reinforced concrete girder, 2'-10" deep at the ends and 5'-5" deep at mid-span.

Each parapet wall's outer face is decorated with panels whose perimeters parallel the outline of the wall. The panels are indented in two stages, each two inches deep; the outermost border is thicker at the top, but the inner border is of uniform width. Mid-span is marked by a

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[37] Octoraro West No. 7 (1911) and Little Beaver No. 2 (1917) in Lancaster County, Bridge Docket.

[38] Most dimensions from Pennsylvania Department of Highways, "Supplementary Bridge Record," 11 February 1943, BMS No. 36-1010-0050-1342, bridge inspection files, PennDOT District 8-0, Harrisburg, Pa.; others from measurements taken by author.

[39] Complete text of plaque on bridge:

LANCASTER COUNTY.	
COMMISSIONERS:	S. W. DILLER
	J. R. SHIRK
	D. F. MACEE
ENGINEER:	F. H. SHAW
CONTRACTOR:	P. D. KAUFFMAN
SAFE LOAD -20- TONS	1917

[40] Pennsylvania Department of Transportation, bridge inspection report, 13 January 1987, BMS No. 36-1010-0050-1342, bridge inspection files, PennDOT District 8-0, Harrisburg, Pa.

circle of 1'-8" diameter, indented four inches from the outermost surface. Though weathering and patching have eroded this decoration, it still breaks up an otherwise flat concrete surface.

Because of its curving profile, the parapet wall is too low at the ends to serve as a railing. Therefore a non-structural railing surmounts the girder at either end. A concrete post, 1'-4" wide, 2'-7" tall, and 3'-0" long, is cast integrally with the end of the parapet. It is connected by a 8'-0"-long concrete rail, 4" wide and 8" high, to the next post, also integrally cast, 1'-4" wide, and 10" long. A 4-inch chamfer crowns both posts, whose tops are roughly level with the crown of the parapet. The rail, which sits just below the chamfer, continues past the second post to merge with the parapet. Several pieces of rail are missing from the bridge, and judging from the neatly rectangular sockets in the posts, the rail was cast separately. Where the rail is broken, one can see that its small cross-section contains only four bars of 1/2"-square longitudinal reinforcement, two each at top and bottom, and no shear reinforcement.

At mid-span, and at either end, the floor slab is 1'-9" thick and serves as both bridge deck and arch ring. In order to maintain a level road surface, the floor slab must become thicker over the piers. However, no plans exist to reveal whether this thicker portion is comprised of separate deck and ring slabs with fill between or simply monolithic concrete.

Outside the span, the abutments are concrete walls without decoration. The curving wing walls are capped by solid concrete guard walls, matching the thickness and height of the railing's end posts, with a coping projecting two inches. Ranging in length from 27'-0" to 48'-0" and curving at different radii, the wing walls seem determined by the previous bridge. At either end of each guard wall, the coping turns downward into a pilaster; at the end adjacent to the bridge, this pilaster terminates level with the intrados of the cantilevered arch. Although the shorter guard walls of an earlier bridge described by Percy A. Shaw were unreinforced, those on the Farmersville Road bridge have sporadically placed 1/2"-square vertical rods near each end of the wall.[41] The western guard walls have been cut down to improve visibility, revealing this light reinforcement scheme.

Structural Form

An inventory of Pennsylvania's historic bridges, compiled by A. G. Lichtenstein and Associates contemporaneously with this report, acknowledges that Shaw's design for the Farmersville Road bridge "has a high degree of technological significance given its date of construction."[42] While the idea for a cantilevered design probably did not originate with Shaw, it seems to be a relatively new idea when discussed in a 1916 text.[43] Shaw does deserve credit for

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[41] Shaw, "A Reinforced Concrete Through Girder Bridge," 744.

[42] A. G. Lichtenstein and Associates, "Pennsylvania Historic Bridge Inventory and Evaluation," BMS No. 36-1010-0050-1342, March 1997.

[43] George A. Hool and Frank C. Thiessen, *Reinforced Concrete Construction,* 1st ed. (New York: McGraw-Hill, 1916).

recognizing that the cantilever form allowed longer spans (and therefore fewer piers), was an economical solution given existing site conditions, and could be strengthened by through girders for even greater efficiency. The most remarkable aspect of the cantilevered through-girder design is its contrast to concrete bridges a decade earlier or later. The earliest reinforced concrete bridges, of course, resembled the arches of their masonry predecessors. Experimentation with trusses and through-arch forms such as Marsh's "rainbow arches" followed, only to be quashed by state standards for concrete bridges.[44] Indeed, Big Conestoga Creek Bridge No. 12 would have taken on an entirely different form in the decades before or after its construction.

One can stand on the bridge which Shaw designed and feel how it works. As a truck passes the center of the bridge, the cantilever tips flex perceptibly upward, demonstrating the span's structural continuity. This movement reminds the pedestrian with one foot on the bridge and one on the abutment that the two are not connected. The parapet wall's profile also tells something about how the cantilevered form works. Since cantilever action transfers loads by bending over the supports, thus compressing the bottom of the structure, the arches below the deck make sense. Likewise, loading at mid-span results in compressive stresses at the top, where the parapet wall has its maximum height above the deck. In other words, the bridge's profile resembles the shape of a bending moment envelope for a number of load cases.

Shaw's cantilevered through girder bridges are designed for material economy. Most prominently, the through girder concept combines structural support and protective railing into a single element. Instead of casting a non-structural railing on top of a deck girder or arch bridge, the through girder's railing supports the bridge. For a relatively narrow and short span, the through girder saves a significant amount of material. However, as George A. Hool correctly noted in *Reinforced Concrete Construction* (1916), the thicker floor required for wider spans makes the through girder increasingly inefficient.[45] The lack of redundancy in a design where the same element supports vehicle loads and resists their impact also caught the criticism of authors at the time. G. P. Manning wrote, "For narrow bridges where headroom is very scarce parapet [through] girders may be used. Some authorities (quite rightly) forbid their use."[46] Nonetheless, the through-girder design allowed Shaw to construct a large number of bridges with a limited budget.

Shaw's cantilevered through-girder design is materially efficient in another, more subtle way. Because the cantilevered form does not rest upon its abutments, older abutments of poor quality could be reused, encased in enough concrete to carry traffic loads. Though the 1911 *Engineering Record* article describes a single, simply supported span, it provides insight into the bridge at Farmersville Road. For instance, the article describes how abutments and wing walls

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[44] Although a 1919 state standard for concrete bridges are mentioned in Anderson, "Old Covered Bridge," this is probably not the first such standard.

[45] Hool and Thiessen, *Reinforced Concrete Construction,* 407.

[46] G. P. Manning, *Reinforced Concrete Design,* 2nd ed. (New York: Longmans, Green & Co., 1939), 458.

from a previous bridge were encased in reinforced concrete and re-used for the new bridge. Given the short construction time and low cost of the Farmersville Road bridge, Shaw probably reused the abutments of the 1845 covered bridge at that location.[47] This saved both construction time and material requirements. The geology of Lancaster County also helped to reduce costs: the 1911 article mentions abutments founded in rock, and an inspection report for Big Conestoga No. 12 indicates the same situation there.[48]

However, Shaw's embellishment of the bridge at Farmersville Road indicates concerns other than economy. In the early days of reinforced concrete, much was written on the aesthetics of concrete bridges. In Hool's 1916 text, an entire section by William J. Titus detailed "The Artistic Design of Concrete Bridges." He wrote,

> Only with the coming of the automobile have we begun to realize that the roads and bridges of the suburban and more remote country districts are as deserving of careful and artistic bridge design as those in our cities and other thickly populated districts.[49]

Shaw may have heeded these very words, for even his shortest simply-supported spans have curved top chords and surface relief. Big Conestoga No. 12 compares favorably with many of Titus' guidelines: symmetry, an odd number of spans, recessed panels rather than raised, and undecorated wing walls.[50] The bridge at Farmersville Road reflects the prevailing aesthetic expression in concrete structures.

Comparing this bridge to a similar cantilevered through girder designed by Shaw in 1914, Big Conestoga No. 6, one can see that his design underwent some refinement.[51] The earlier bridge's parapet wall was horizontal across the middle span and sloped down linearly to each abutment, relieved by rectangular and triangular panels. The underside of that bridge was a series of flat slabs. According to Shaw's brother Percy, the intent of depressed panels was, at least for their early bridges,

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[47] Regarding the cost, a rough comparison can be made between Big Conestoga Creek No. 11, where the abutments were re-used, to the Farmersville Road bridge (No. 12). Shaw, "A Reinforced Concrete Through Girder Bridge," 745, indicates a cost of $4,334.57 for No. 11, or $68.80 per foot spanned. According to Lancaster County, Bridge Docket, 127, Big Conestoga Creek No. 12 (of comparable width) cost $7,816.00 or $59.66 per foot.

[48] Pennsylvania Department of Highways, "Supplementary Bridge Record."

[49] William J. Titus, "Artistic Bridge Design," in Hool and Thiessen, *Reinforced Concrete,* 494.

[50] Titus, "Artistic Bridge Design."

[51] Photograph in Lancaster County, Bridge Docket.

> to save weight, but ornamentation was omitted to keep down the cost of form work. The span depends for whatever beauty it possesses on the bold, clean lines of the massive concrete work.[52]

However, at Big Conestoga No. 12 in 1917, one finds Frank using a parapet wall with a curving profile, doubly-indented panels, a whimsical circle at mid-span, and open railings. These features certainly require more than minimal form work and represent a departure from absolute economy.

Survival

The Farmersville Road bridge owes its survival to a number of factors. Though its width falls below current standards, Shaw used a 20-ton design load. With this relatively large design load for its time of construction, the bridge carries modern traffic without a posted weight limit. A nearby bridge of modern construction provides a convenient bypass for heavier vehicles; this happens to be mentioned in a proposed replacement scheme that failed to attract funding.

Because of its late date of construction, the Farmersville Road bridge was designed with the awareness that trucks were joining the increasing automobile traffic. A reinforced concrete manual contemporary to its construction advocates a 20-ton truck loading, adding that "because of the permanent character of concrete bridges it may be wise to provide a larger margin for increase of loading."[53] Reinforced concrete arches of a slightly earlier vintage cannot carry modern trucks, fire engines, or school buses; they are often declared functionally obsolete and replaced. However, the builder's plate at mid-span of the Farmersville Road bridge confirms that Shaw designed it for a safe load of 20 tons.

A bridge of identical design, crossing Conestoga River approximately 6500 feet to the south, was replaced in 1955 with a span of width and capacity that more or less still apply at present.[54] The former structure was Big Conestoga Creek Bridge No. 13, also designed by Shaw and built by Kauffman. Because this bypass exists, the Farmersville Road bridge is not a critical link in the road network. Still, the Pennsylvania Department of Highways began considering a replacement for the Farmersville Road bridge in 1970.[55] The proposal included a re-alignment of Farmersville Road, crossing Conestoga River along the line of Brownstown's Main Street.

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[52] Shaw, "A Reinforced Concrete Through Girder Bridge," 744.

[53] Hool and Thiessen, *Reinforced Concrete,* 15.

[54] Pennsylvania Department of Transportation, "Hydraulic Report: Lancaster County L.R. 36032 Station 70+59 Over Conestoga Creek," 26 March 1970, BMS No. 36-1010-0050-1342, bridge correspondence files, PennDOT District 8-0, Harrisburg, Pa.

[55] Pennsylvania Department of Transportation, "Hydraulic Report."

According to a hydraulic study, the existing bridge would be abandoned in place.[56] The state finalized the replacement proposal in 1972, but failed to fund its construction.[57]

Conclusion

Big Conestoga Creek Bridge No. 12 is the surviving work of an innovative reinforced concrete engineer, Frank H. Shaw. Its rare combination of arch, cantilever, and through-girder forms respond to existing site conditions and economic constraints. Though unacceptable by modern standards for highway bridges, the through-girder design efficiently combines support and railing into one element. Shaw's bridge-building program, which produced six similar bridges and even two concrete trusses, answered political pressure for "permanent" structures to carry ever-increasing automobile traffic. These unusual structural forms were possible only in the narrow window of time between the invention of reinforced concrete and the advent of state standards for bridge design. Built one decade earlier or later, the bridge on Farmersville Road would have assumed an entirely different form.

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[56] Pennsylvania Department of Transportation, "Hydraulic Report."

[57] "Three Distinctive County Bridges Named to Historic Register."

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APPENDIX A: Reinforced Concrete Trusses and Cantilevers in Lancaster County

Year	Name	Township(s)	Span	Type	Builder
1914	Big Conestoga No. 6	East Earl	131'	3-span cantilever through girder	John S. McIlvaine
1916	Big Chickies No. 4 (extant)	Penn/Rapho	62'	truss	J. Miller Eshleman
1916	Big Conestoga No. 7 (extant)	East Earl	59'	truss	John F. Brubaker
1917	Cocalico No. 6	Ephrata/Warwick	131'	3-span cantilever through girder	Paul D. Kauffman (Reading)
1917	Big Conestoga No. 12 (extant)	West Earl	131'	3-span cantilever through girder	Paul D. Kauffman (Reading)
1917	Big Conestoga No. 13 (demolished 1955)	West Earl	131'	3-span cantilever through girder	Paul D. Kauffman (Reading)
1927*	Big Conestoga No. 2	Caernarvon	126'	3-span cantilever through girder	Ira J. Reighter (Harrisburg)
1927*	Pequea No. 13 (extant)	Strasburg	132'	3-span cantilever through girder	M. Rorabaugh (Mountville)

* S. Z. Studenroth, who had worked in Frank H. Shaw's office, was county engineer in 1927.

Source: Lancaster County, Bridge Docket, Lancaster County Engineer's Office, Lancaster, Pa.

APPENDIX B: Figures

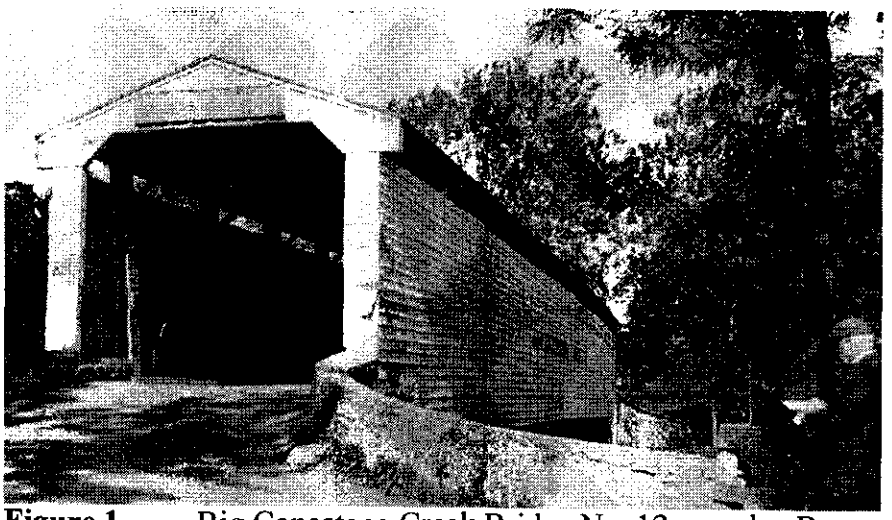

Figure 1. Big Conestoga Creek Bridge No. 12, wooden Burr arch-truss constructed by Elliott and Russell in 1845. Source: Lancaster County, Bridge Docket, Lancaster County Engineer's Office, Lancaster, Pa.

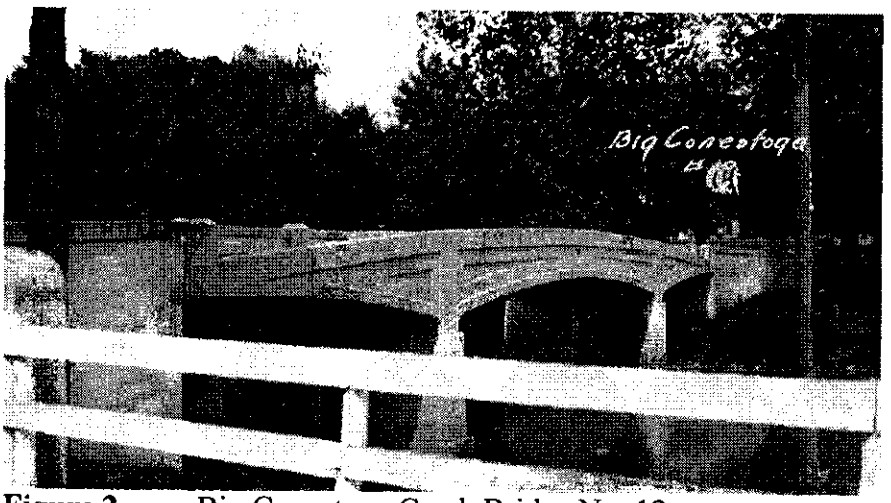

Figure 2. Big Conestoga Creek Bridge No. 12, concrete cantilevered through girder constructed by Paul D. Kauffman in 1917. Source: Lancaster County, Bridge Docket, Lancaster County Engineer's Office, Lancaster, Pa.

ADDENDUM TO:
BIG CONESTOGA CREEK BRIDGE NO. 12
Spanning Conestoga River at Farmersville Road (State Route 1010)
Brownstown vicinity
Lancaster County
Pennsylvania

HAER PA-500
PA,36-BROTO.V,1-

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