OLD MILL ROAD BRIDGE
(County Bridge No. 16)
Old Mill Road Spanning Saucon Creek
Hellertown Vicinity
Northampton County
Pennsylvania

HAER No. PA-93

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

Historic American Engineering Record
National Park Service
Department of the Interior
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HISTORIC AMERICAN ENGINEERING RECORD

OLD MILL ROAD BRIDGE
(County Bridge No. 16)

HAER No. PA-93

Location:	Spanning Saucon Creek on Old Mill Road, at Ehrhart's Mill, near Hellertown, Northampton County, Pennsylvania UTM: 18/410490/4489880 Quad: Hellertown, Pennsylvania
Date of Construction:	1870. Bridge and approaches rebuilt in the 1930s and in 1948
Fabricator:	Charles Nathaniel Beckel, Beckel Iron Foundry and Machine Shop Sand Island, Bethlehem, Pennsylvania Kern, Sheffler and Company received contract for masonry wing walls and pier
Present Owner:	Lower Saucon Township of Northampton County, RD 3, Bethlehem, PA 18016
Present Use:	Pedestrian traffic
Significance:	One of two existing pony-truss spans built by the Beckel Foundry. Both used variations of Francis C. Lowthorp's 23 June 1857 and 13 March 1860 patented cast lower-chord connections. The Old Mill and the Walnut Street bridges incorporate unusual cast-iron beams to support decks.
Historian:	Robert W. Hadlow, August 1991

The Old Mill Road Bridge, spanning Saucon Creek in Lower Saucon Township, Northampton County, Pennsylvania, is a composite cast- and wrought-iron pony-Pratt truss span. It is one of the oldest all-metal bridges in the United States and is one of three spans fabricated at the Beckel Iron Foundry that still exist. Composite cast- and wrought-iron spans are part of a small window in a transition period when bridge technology and materials evolved from wood and iron, to cast- and wrought-iron, to wrought-iron and, finally, to steel. Fragmented records available from Northampton County reveal little about the Old Mill Road Bridge. A line item from a volume listing county receipts and expenses from 1855 to 1883 suggests that the bridge was erected in 1870, at a cost of $2,400 for iron work and $750 for masonry.[1]

The Old Mill Road Bridge is situated adjacent to a number of structures that once functioned as a grist mill, housing, and outbuildings. Collectively, including the bridge, they form the Ehrhart's Mill Historic District, listed on the National Register of Historic Places in 1986.[2]

Previous Spans

There is no evidence to suggest that the bridge may have replaced a previous structure. A "freshet" (an overflowing of streams caused by heavy rains) on 3 October 1869, caused the loss of many spans crossing the Lehigh, South Raritan, and Delaware Rivers in southeastern Pennsylvania and western New Jersey. But no documentation has been found to suggest that a previous bridge was lost at this crossing when Saucon Creek overflowed its banks. There was and still is alternative access to the mill from roads to the north and west.

Significance of District

In the mid-eighteenth century, Christian Boeydler, one of many German immigrants to settle in the colony of Pennsylvania, took advantage of the water power that Saucon Creek provided and established a grist mill. He sold the land and improvements in 1751. After passing through various owners, they were purchased in 1820 by Joseph Ehrhart who, with suceeding generations of his family, constructed or renovated the many buildings that today comprise the mill's historic district. In the immediate post-Civil War years, the Ehrharts easily expanded their market by importing midwestern grain and selling their milled flour, taking advantage of rail lines offering better access to the mill. In 1959, Bethlehem Steel Corporation purchased the property, dynamiting the mill dam to prevent flooding of their adjacent

golf course. The Yeakel-Ehrhart family continued to operate the mill complex as a feed store until the 1970s. A recent owner restored the mill and residential buildings and sought listing on the National Register of Historic Places for the property and the cast- and wrought-iron pony-truss Old Mill Bridge.[3]

Charles Nathaniel Beckel

Northampton County embarked on an ambitious bridge building campaign in the 1860s and 1870s. From 1861 to 1874 it let contracts for at least seventeen iron spans, ranging in cost from $1,400 to $5,400. One prominent fabricator during these years was Bethlehem's Charles Nathaniel Beckel.[4]

Beckel's father, Charles Frederick, was from a prominent Bethlehem Moravian family. In 1825 he purchased a small foundry located on the edge of the city's business district. A year before, Joseph Mikseh, a locksmith, had begun its construction but died before completing it. Charles F. Beckel was a watchmaker who purchased the foundry and machine shop from Mikseh's estate in early 1825 and began working iron. By 1829 he moved his operation to an island between the Lehigh River and the newly completed Lehigh Canal to take advantage of water power to operate his blast.[5]

The Beckel Iron Foundry and Machine Shop, under the direction of Charles Frederick, was most noted for its cast cookware and farm implements. Not until Charles Nathaniel entered the business in the late antebellum years did the firm begin to produce ornamental fences and fence posts, hot air furnaces for homes and public halls, large clocks for church towers and municipal buildings, and cast- and wrought-iron bridges.

Charles N. Beckel was born in Bethlehem, in 1827. According to family histories and his obituary, he apprenticed as a cabinetmaker after completing his schooling at the local Moravian Parochial School. He became an expert in carving wood patterns used in casting iron at his father's foundry. Sometime in the late 1850s, he studied iron bridge "design, manufacture and erection" under "one of the most prominent engineers and bridge builders in the country," probably Francis C. Lowthorp of Trenton, New Jersey, an engineer who had taken out patents on many components used in cast- and wrought-iron bridges. Lowthorp had at one time been master bridge builder for the New Jersey Central Railroad.[6]

The Beckel Foundry erected twenty-one iron bridges throughout the state from 1861 to 1885, principally in Northampton, Lehigh, Lancaster, and Bucks counties. But C. N. Beckel did venture out

of Pennsylvania on at least one occasion, to work with F. C. Lowthorp in 1864 on a drawbridge across Newark Bay in New Jersey. Charles N. Beckel suffered a stroke in August 1879, and lived as an invalid from then until his death in March 1888.[7]

Design of the Old Mill Bridge

Old Mill Road Bridge is a counter-braced pony-Pratt truss consisting of two consecutive 52' long, 8' high, five-panel spans. The cast- and wrought-iron superstructure spans 104' between stone abutments at the embankments, with a mid-stream, concrete-encased, battered masonry pier, and supports a 15 foot-wide deck.

A Pratt truss is a simply-supported structure in which the chords resist the structure's tendency to bend by developing internal compression forces at the top and tension forces at the bottom. The web resists overall shear by developing internal compression forces in vertical panel posts and tension forces in diagonal braces. Iron bridges from the 1850s through the early 1870s typically used less expensive cast iron, a brittle material weak in tension, for compression elements, and wrought iron, a strong ductile material, for tension elements. Designers proportioned structural members to resist forces efficiently while minimizing material and, consequently, weight and costs.

The upper chords and inclined end posts of the Old Mill Road Bridge were made from hollow iron castings with an octagonal cross section. This was an appropriate form because it was rigid enough to prevent the tendency of long, unbraced compression members to buckle or bend out under compressive force. Hollow iron castings also formed the tapered cylindrical web posts. The baseplate of the bridge's central post bearing points was fastened to the pier, permitting no lateral movement. The baseplates of the end post bearing points rested on rollers that allowed longitudinal movement of the truss.

The hip verticals were compression members, identical to the web posts. This variation on the usual Pratt truss arrangement in which hip verticals act in tension as suspenders supporting the lower chord, was a modification resulting from the incorporation of counterbraces.

The panels were braced by pairs of wrought-iron rods. Those nearest the supports, where the shear resisted by the truss was greatest, have larger diameters. Single rod counter-braces passed between each brace pair. Their purpose was to stabilize the truss when loaded on one side only, an essential function for all light weight iron trusses carrying live loads that were large

compared to the structure's own weight. To prevent the braces from loosening when the counter-braces were in action, it was customary to give the braces, counter-braces and lower chords an initial tension. This action developed internal forces in an unloaded bridge that combined with the forces caused by applied loads. In a cast- and wrought-iron structure, this "pre-tensioning" had the effect of stiffening the bridge, and in some cases reducing unwanted tension stress in cast-iron components. In the Old Mill Road Bridge, brace rods could be tightened at the lower-chord connection casting where square or hexagonal nuts secured the threaded ends.

The lower-chord assembly consisted of two wrought-iron square bars. Bar segments had eyes forged at each end and were connected to wrought-iron pins at all panel points except for the embankment supports, which were threaded for tensioning adjustments.

Beckel employed at least one and maybe two patented lower-chord castings perfected by Trenton, New Jersey, engineer Francis C. Lowthorp. In his letters of patent of 30 June 1857, No. 17,684, Lowthorp claimed to have invented a practical, economical type of "lower-chord plate" through which bridge fabricators could connect wrought-iron tension members, such as eye-bar diagonal counters and threaded lower-chord rods.

Lowthorp's second lower chord connection patent, No. 27,457, dated 13 March 1860, presented a modification to the 1857 patent. He replaced the brace-rod pin connection with anchorages for threaded rods. The chord rods were attached by "T-heads".

In his lower-chord castings, Beckel used Lowthorp's 1857 casting design incorporating a through pin, but also utilized the 1860 patent design for the connection of diagonal braces, that is the use of threaded wrought-iron rods. In addition, Beckel also cast the deck beams and the lower-chord connection plates as one integral piece.

Although the design of the integral connection plates follows closely the Lowthorp patents, that of the lower chord differs. In the Old Mill Road Bridge the strategy for connecting the lower chord and the panel braces was reversed from the version shown in the 1857 patent. The chord was made from eye bars, connected to the pins, and the braces were threaded rods, bolted to the plate. The lower-chord casting, termed a "straining plate" by Lowthorp, was essentially an extension of the end of the beam modified to provide a keyed seat for the panel web post, anchorage for panel and lateral bracing rods, and a pin for the attachment of the lower-chord bars.

Lowthorp addressed many issues in the texts of his patent claims. These included the requirements of fabrication, transport, erection, maintenance, and in-service performance while emphasizing structural integrity coupled with material economy. The casting, Lowthorp claimed, was designed to permit a more economical lower-chord assembly that could easily be adjusted or replaced if needed. This he accomplished without imparting tensile forces to the "straining" plate, which could be constructed from less expensive, easier to shape, cast iron. In the Old Mill Road Bridge, the lower-chord segments transmit tension forces through shearing action in the wrought-iron pin without significantly affecting internal forces in the lower - chord casting.

The cast-iron deckbeams were given "I" shaped cross sections, specifically designed to resist tension stresses with a material weak in tension. Tapered bottom flanges curved in plan and were widest at mid-span, distributing material to minimize flange tension stresses. The top flange, subject to compression force only, was narrower and of uniform width. Stiffeners, cast beneath the top flange, increased resistance to buckling. Web stiffener ribs were cast integrally with the web plate to form a four-panel truss-like pattern of diagonals. These deck beams also functioned as compression struts that, when combined with the lateral cross bracing, formed part of the lateral bracing assembly of the superstructure. Interestingly, this additional role, rather than further taxing the beam, may have served to relieve critical tensile stresses. If the lower lateral cross bracing rods were given an initial tension, the resulting compression force in the deck beams acted as a kind of compressive prestressing to counteract the internal tension forces imparted by bending. The position of the lateral brace connection, nearer the beam lower flange, imparted an upward camber when initially tensioned.

Although the truss appeared to be a continuous structure with an intermediate support, it behaved more as if it were designed as two separate spans with a shared end post. A continuous structure would arch over the center support, developing tension in the upper chord and compression in the lower chord. The lower chord, because of its slenderness, could not resist significant compressive force. The upper chord, because of its material and connection design, could not resist significant tensile force. The tendency for the upper chord to pull apart and the lower chord to buckle created a kind of discontinuity. A simple analysis shows that the lower-chord segments of the panels adjacent to the central pier could be eliminated while the bridge remains intact. In the actual bridge, the degree to which the

structure behaves continuously or not could be affected by the amount of initial tensioning force applied to the lower chord and panel braces. Theoretically, compression forces resisted by the lower chord could be counteracted by the available initial tensioning.

Repair and Maintenance

Complete maintenance records for the Old Mill Road Bridge, once available, no longer exist. Historic American Engineering Record staff who measured the span in 1986 reported examining a county-wide portfolio listing repairs to all bridges under municipal jurisdiction. Since that time, however, the County Engineer's office has experienced a turnover in personnel and can no longer locate those records. A "bridge card" from the turn of the century states that C. N. Beckel was builder of the span near the old mill in 1870, but it shows no record of maintenance.[8]

The first document listing repairs made to the bridge appears in a 1902 contract. In late February of that year the Lehigh Valley experienced another freshet, the first since October 1869. Officials blamed it for hundreds of thousands of dollars damage to buildings, railroad rights-of-way, and highway bridges. In early October, the county approved a contract with John McInverny of nearby Easton to remove and replace the old masonry and place the "present superstructure" on a "finished pier."[9]

According to HAER staff, records seen in 1986 revealed that one or more of the bridge's cast-iron deck beams failed in the 1920s. As a result, the county strapped modern steel I-beams to them in an effort to add strength. A plaque placed in the approach masonry wall of the span states that the county rebuilt the bridge in 1948, but the particulars are unknown. The rebuilding probably involved construction of the approach walls, concreting the existing pier, and miscellaneous repairs.[10]

Northampton County officials closed the span to vehicular traffic in 1983 because cracks developed in deck beams, making the span unsafe for even the lightest live loads. Maintenance records, though, are unavailable to confirm this. The county Public Works Department believed the bridge no longer met required load standards and applied to the Pennsylvania Department of Transportation (PennDOT) for an allocation of $385,000 from the "County Liquid Fuel Tax Funds" to construct a new bridge at the site in 1986. The county planned for a 36-ton, two-lane span to carry traffic on Old Mill Road; it would no longer maintain the 2-ton, single-lane cast- and wrought-iron bridge if the structure were designated for pedestrian use only. Officials of the Public Works Department hoped the local government of Lower Saucon

Township might take responsibility for the old bridge. The alternative would be its destruction.[11]

By January 1987, Lower Saucon Township was preparing to begin construction, wishing to proceed for fear of losing Liquid Fuel Tax funds earmarked for the project. Nevertheless, Kenneth and Hope LeVan, who recently had purchased the Ehrhart's mill complex, requested that Northampton county repair the old structure to accommodate light vehicular traffic and not proceed with plans to replace the bridge with a modern span. They believed that loss of the old structure would compromise the historical significance of the mill site. Kenneth LeVan had learned from PennDOT officials that funds were available for the repair of old spans and, in at least one case, had been used to refurbish a bridge near Pottsville.[12]

In part out of fear of losing the Old Mill Road Bridge in the name of modern road construction, Kenneth LeVan applied for listing on the National Register of Historic Places for the Ehrhart's Mill district, which included the cast- and wrought-iron bridge. If approved, the listing on the register would dictate how the span could be modified. County Director of Public Works John F. Giesen believed that if the county were to repair the bridge, it should bring it up to PennDOT standards for load carrying capacities; anything less would increase the county's liability if there were a mishap on the span. He did acknowledge that structural revisions necessary to keep the bridge open to vehicular traffic would compromise its historical integrity, something that the LeVans and others might not have envisioned. In addition, the county could no longer maintain the bridge with Liquid Fuel Tax allocations if it were strictly for pedestrian use. The final concern was for emergency vehicle access to Old Mill Road. Since the bridge's closure, an alternative route required ambulances and fire fighting vehicles to travel additional miles and over a sub-standard masonry arch to reach locations bordering Old Mill Road.[13]

County and township officials met periodically over the next few months attempting to determine a course of action. County officials eagerly pushed for a decision, fearing the loss of Liquid Fuel Tax dollars allocated for construction of a new span on Old Mill Road. Finally, in August 1987, the local fire chief suggested that simply replacing the bridge would not solve the problem of access to Old Mill Road for emergency vehicles. He believed that the route itself needed extensive rebuilding and widening to safely accommodate the heavy fire fighting equipment. This construction would be impossible on the portion of the road between the grist mill and the miller's house, given the narrow

right-of-way there and the need to maintain the historical integrity of the district.[14]

By February 1988, Lower Saucon Township rescinded its request for a new bridge over Saucon Creek on Old Mill Road. It then asked the county to redeck and repair the span for pedestrian use. The county Public Works Director authorized this work and approved transferring ownership of the span to the municipality. On 16 March, Lower Saucon Township accepted ownership of the cast- and wrought-iron bridge.[15]

Project Information

This recording project is part of the Historic American Engineering Record (HAER), National Park Service. It is a long-range program to document historically significant engineering and industrial works in the United States.

The Cast- and Wrought-Iron Bridges Recording Project was co-sponsored in 1991 by the Historic American Engineering Record and the West Virginia University Institute for the History of Technology and Industrial Archaeology. Fieldwork, measured drawings, historical reports, and photographs were prepared under the general direction of Dr. Robert J. Kapsch, Chief, HABS/HAER; Eric N. DeLony, Chief and Principal Architect, HAER; Emory L. Kemp, Director, Institute for the History of Technology and Industrial Archaeology; and Dean Herrin, HAER Staff Historian.

The Recording Team consisted of Christine Ussler (Architecture Faculty, Lehigh University), Architect and Field Supervisor; Christine Theodoropoulos, P.E. (Architecture Faculty, California State Polytechnic University, Pomona); Wayne Chang (University of Notre Dame), Monika Korsos (Technical University of Budapest, Hungary, US/ICOMOS), Architectural Technicians; Robert W. Hadlow (Washington State University), William Chamberlin, P.E., Historians; and Joseph E. B. Elliott (Muhlenberg College), Photographer.

The documentation of Old Mill Bridge began in 1985 with field notes made by Eric DeLony, Chief, HAER; Richard K. Anderson, Jr., Architect, HAER; Carolyn Givens (University of Kansas), and Lori Allen (Iowa State University), Architectural Technicians. Jet Lowe, HAER Photographer, made images of the bridge. In 1986 Coy Burney began three sheets of drawings.

APPENDIX 1.

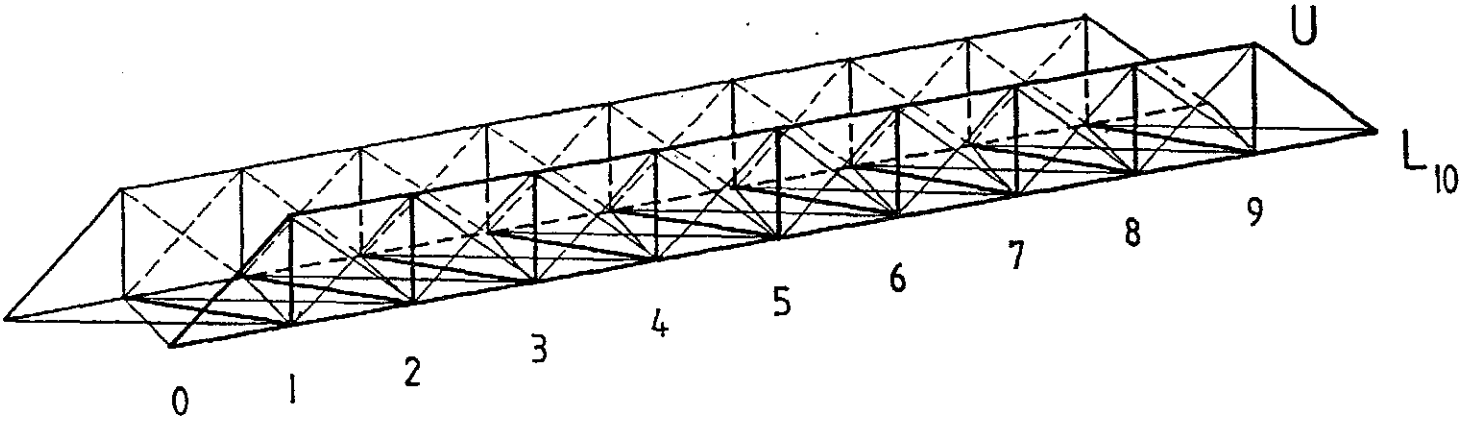

Table A: Bridge Dimensions

Truss type	Pratt pony truss
Number of spans	2
Number of panels per span	5
Panel width, center to center of web posts	10'- 6"
Width of end bays, L_0 to L_1	10'- 2 1/2"
Total bridge length, L_0 to L_{10}	104'- 5 3/8"
Span, L_5 to L_{10}	52'- 2 7/8"
Distance between upper and lower chords, center to center	7'- 9 1/2"
Truss spacing, center to center	15'- 0"

Data Limitations

Various sources were consulted in preparing this report. They include local, county and state government records, historical society archives, and library holdings.

Lower Saucon Township records do not exist prior to 1914. Most County Records are located in the County Archives in Easton. They are not indexed and extremely difficult to utilize. County Commissioners' Minutes for the second half of the 19th century are missing. The only portion of the collections labeled "roads and bridges" was a partial run of contracts dating from the 1890s through the 1940s.

In Pennsylvania, bridges on borough, township, or county roads are under the jurisdiction of the County Office of the Director of Public Works. A maintenance file for this bridge was found in Easton but was not current since the bridge was no longer county property. At one time, the county engineer's office, under the jurisdiction of the Director of Public Works, had a large "portfolio" collection of maintenance records for all older county-owned bridges. This was last seen by HAER officials in the mid-1980s. Since then it has vanished.

Neither the Lower Saucon Township Historical Society ellertown Historical Society nor the Northampton County Historical Society in Easton had records that might help researchers to learn more about the Old Mill Road Bridge. The Bethlehem Public Library has a large collection of local histories, newspaper scrapbooks, and vertical files that might aid the researcher. The Lehigh University Libraries' Archives and Special Collection's Division has many nineteenth century monographs on bridges and bridge building. There are few, if any references to Francis C. Lowthorp or Charles N. Beckel.

The only sources on the Beckels of Bethlehem, Pennsylvania, see: Ralph Levering Beckel, "Genealogical and Biographical Record of the Pioneer George Frederick Boeckel (Beckel) and His Descendants," Tms, 1942, and Frederick Truman Beckel, "The Boeckel (Beckel) Family of Bethlehem, Pa," Tms, 1968, both found in the Bethlehem Room, Bethlehem Public Library, Bethlehem, PA. The organization, Historic Bethlehem, Inc., of Bethlehem, PA, has the most complete set of records from the Beckel Foundry. But these only include a fragmented collection of daybooks and ledgers. They shed little, if any, light on the period when C. N. Beckel and his son, L. L. Beckel fabricated bridges.

ENDNOTES

1. Northampton County, Pennsylvania, "New Bridges," 1870, Record of Receipts and Expenditures, County Archives, Easton, Pennsylvania.

2. See U.S., Department of the Interior, National Register of Historic Places, "Ehrhart's Mill Historic District," nomination, (1986), 1, passim.

3. Ibid., 7-1, 8-1, and 8-2.

4. Northampton County, Pennsylvania, "New Bridges" and "Bridge Repairs," 1855-1883.

5. History of Northampton, Pennsylvania with Illustrations Descriptive of its Scenery, Philadelphia and Reading: Peter Fritts, (1877), 204; Joseph Mortimer Levering, A History of Bethlehem: 1741-1892, Bethlehem, PA: Times Publishing Co., (1903), 669.

6. Ralph Levering Beckel, compiler, "Genealogical and Biographical Record of the Pioneer George Frederick Boeckel (Beckel) and His Descendants and including Genealogical and Biographical Records of Some Families Interrelated by Marriage, 1942" TMs [photocopy], pp. 36, 39, Bethlehem Room, Bethlehem Public Library, Bethlehem, Pennsylvania; Manufactories and Manufactures of Pennsylvania of the Nineteenth Century, (Philadelphia: Galaxy Publishing, 1875), 490; "Obituary--Charles Nathaniel Beckel," Daily Times (Bethlehem), 8 March 1888, 1.

7. "Obituary--Charles Nathaniel Beckel," Daily Times, (Bethlehem), 8 March 1888, 1.

8. Bridge Card, Bridge No. 16, Engineer's Office--Gracedale, Northampton County, Pennsylvania.

9. "Historical Facts on Lehigh River Floods Recalled in Lecture: H. G. Payrow Reviews Extent of Damage Done, Together with Technical Data," Globe Times (Bethlehem, Pennsylvania), [May 1931], in Clipping Scrapbook, Bethlehem Room, Bethlehem Public Library; Northampton County, Pennsylvania, "Agreement between

John McInverny and the County of Northampton, Made on 3 October 1902," Roads and Bridges Records, County Archives, Easton, Pa.

10. For confirmation of HAER reports on documentation of maintenance for this bridge see Eric N. DeLony, Principal Architect for HAER, to Don Keller, Keller Consulting Engineers, 30 December 1986, copy attached to National Register of Historic Places Nomination for the Old Mill Road Bridge.

11. "Application for Expenditure of Liquid Fuel Tax Allocations," Bridge No. 16, Bridge Files, Department of Public Works, Northampton County, Government Center, Easton, Pennsylvania; Laurie Loewenstein, "Experts Hope to Save Bridge in L. Saucon," Globe-Times (Bethlehem, PA), 31 July 1985, B1, B2.

12. Tad Miller, "Neighbor Says Funds Available to Save Historic Span," Morning Call (Allentown, PA), 19 January 1987, B4B.

13. John F. Giesen, Director of Public Works, to Richard Grucela, County Council President, 3 February 1987, in Bridge 16, Bridge Files, Department of Public Works, Northampton County; Ann Marie Gonsalves, "Lower Saucon Council: Save Historic Mill Bridge," Globe-Times, 20 March 1987.

14. Miller, "Mill Listed as National Historic Site," Morning Call, 2 June 1987; Kenneth and Hope LeVan to John Giesen, 12 August 1987, in Bridge Files, Department of Public Works, Northampton County; Miller, "Residents, Fire Chief Oppose Replacing L. Saucon Span," Morning Call, 20 August 1987, B4.

15. Giesen to James L. McCann, Manager, Lower Saucon Township, 12 February 1988, Bridge Files, Department of Public Works, Northampton County; McCann to Giesen, 17 March 1988.

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