OLD CORINTH ROAD BRIDGE
Hadley Parabolic Bridge
Bow Bridge
New York Cast and Wrought Iron Bridges
Spanning Sacandaga River at Corinth Road
Hadley
Saratoga County
New York

HAER No. NY-292

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN ENGINEERING RECORD

OLD CORINTH ROAD BRIDGE
(Hadley Parabolic Bridge)
(Bow Bridge)

HAER No. NY-292

Location:	Carries Old Corinth Road in the Village of Hadley over the Sacandaga River, Town of Hadley, Saratoga County, New York UTM: 18.593625/4796109 USGS Quadrangle: Lake Luzerne, 7.5 minute
Date of Construction:	1885
Designer/Builder:	Based on an 1878 patent granted to William O. Douglas of Binghamton, New York; fabricated by the Berlin Iron Bridge Company, East Berlin, Connecticut
Present Owner:	Town of Hadley, 4 Stony Creek Road Hadley, New York 12835
Present Use:	Closed
Significance:	The Old Corinth Road Bridge, a two-span iron parabolic truss, was built in 1885 by the Berlin Iron Bridge Company, East Berlin, Connecticut to replace a covered timber bridge that crossed the Sacandaga River in Saratoga County, New York. Based on an 1878 patent granted to William O. Douglas of Binghamton, New York, its main span is the only extant half-through truss of the three known to have been built. The bridge represents a period of American bridge building when the shop-fabricated/field-erected metal truss was the dominant structural form of highway crossings in most parts of the country.

While the Berlin Iron Bridge Company was, in many respects, typical of those that dominated the market during the last quarter of the 19th century, it was unique in the degree to which it was able to broker its proprietary parabolic designs during a period when the industry was moving rapidly to a small number of standard truss configurations. In that sense, the parabolic truss was an anachronism. Its success, which lasted well into the 1890s, has been attributed to aggressive promotion and to the economy inherent in its design.

Except for the unusual positioning of the deck with respect to the trusses in its main span, details of the Old Corinth Road Bridge vary little from the company's other parabolic trusses. The bridge's uniqueness in this regard is interpreted as an economical solution to competing needs for lateral bracing and overhead clearance, solution made possible by the ample height of the bridge's deck above the river below. This uniqueness is enhanced by the striking visual impact of the bridge's profile silhouetted against the scenic gorge of the Sacandaga River at this location, and from the rare juxtaposition of two parabolic truss spans of different form in the same bridge.

The Old Corinth Road Bridge has been featured in a variety of publications of national circulation since 1928 and is well recognized among historians of bridge technology. Known locally as the Bow Bridge, it was listed on the

National Register of Historic Places in 1977.

Project Information: Documentation of the Old Corinth Road Bridge was prepared by the Historic American Engineering Record (HAER), National Park Service, during the summer of 1994, as part of HAER's New York Cast and Wrought Iron Bridges Recording Project, with support from the New York State Department of Transportation. When citing this report, please credit the Historic American Engineering Record and the author.

Historian: William P. Chamberlin, PE, Schenectady, New York

I. DESCRIPTION OF THE BRIDGE

A. Site

The subject of this documentation is a two-span iron truss bridge that carries Old Corinth Road over the Sacandaga River in the Town of Hadley, New York. At the time of its closure in 1983, the bridge linked portions of the hamlet of Hadley located on opposite sides of the river; the road serving as an alternate route between the center of the hamlet, north of the river, and Route 9N leading to the Village of Corinth four miles to the south.

The Town of Hadley is located along the northern border of Saratoga County and lies wholly within the 5,693,500 acre Adirondack Park. It is bounded on the south and west respectively by the Towns of Corinth and Day, of the same county, and on the north and east by Warren County. The eastern boundary of the town is defined by the Hudson River, and the southern boundary by the Sacandaga River, which enters the Hudson from the west. The Old Corinth Road Bridge crosses the Sacandaga River in a natural gorge just upstream from where it flows into the Hudson at a widening referred to as the Luzerne Pool. The area is semi-rural in character, being transitional between the lightly populated hamlet and the broken forests to the south and west. The gorge at this location is a site of great natural beauty and seasonal white water recreation.

B. Superstructure

The Old Corinth Road Bridge includes two unskewed spans, both of parabolic truss design[1] with pin-connected joints, fabricated of wrought iron and supported by coarse ashlar stone abutments and a single ashlar stone pier. The shorter approach span is of the low truss style; the larger main span is a "semi-through" style in which the truss chords "arch" both above and

[1]The terms, "parabolic" and "lenticular" have come to be used interchangeably in describing these trusses. The former term was used in the manufacturer's promotional literature and is used here.

below the roadway. The single pier is situated between the larger and smaller spans and supports one end of both. The bridge's overall length is approximately 180' and it supports a 17' wide deck that is about 45' above the river.

The smaller of the two superstructures consists of two unbraced trusses flanking a deck. The floor beams of the deck are suspended by U-bolts from the pins of the lower chord, thus positioning the trusses so that they are almost entirely visible above the deck. Each of the 44'-7" trusses is divided visually by two latticed web posts into three panels, including two end panels measuring over 15' and a single 14' center panel. The upper chords consist of pairs of out-facing channels with riveted cover plates on top and latticing below. Post-to-post floor-level ties, each consisting of two pairs of laced angles serve as the bottom chords in both the end and center panels. The lower chords in the end panels are supported by pairs of eye bars running from the juncture of the web posts and lower chord to the end posts. These bars are rounded and threaded through castings on top of the end posts, to which they are secured by nuts. The trusses, which are 6' deep at center span, are 17'-1" apart measured center-to-center.

The larger span's superstructure is 136' in overall length and has a clear span of approximately 131'. Its trusses are divided into nine approximately 15'-wide panels. The trusses stand 17'-4 1/2" apart center-to-center and are about 18' deep at mid span. In terms of structural detail, the individual truss members are similar to those of the shorter approach span but are of generally heavier cross section. The upper chord is tied by a single horizontal rod between the end-span pins; this rod also braces the web posts in the plane of the truss.

The distinguishing feature of the main span, and that which makes it unique, is the positioning of its floor beams at mid-truss height, where they are connected to the web posts rather than being suspended directly by the lower chord in the more common fashion. This detail required replacing the latticing at those points with solid plates spliced to the web of floor beams. The effect of this feature is to place the deck just above the mid-line of the trusses in a configuration that has been referred to as "semi-deck" or "half-through." Unlike the shorter of the two spans, the upper and lower chords of the longer one are pinned where they meet at the truss ends. They are supported there by short built-up pedestals that rest on the abutment and pier seats.

Each panel of the larger and the center panel of the smaller superstructure is braced horizontally in the plane of the deck by a pair of opposing diagonal tension rods. In addition, the larger span is braced below the deck with built-up struts that extend between opposite panel points on the lower chord of each truss. The span is also braced underneath by pairs of diagonal tension rods that cross both in the plane formed by the struts and the deck beams, and in the plane of the arched lower chord between opposite panel points. A timber deck, covered by 1" of asphalt concrete, is supported by seven parallel iron I-beam stringers that rest on the upper flanges of the floor beams. The iron stringers probably date from the original construction.[2]

The bridge is presently closed to all traffic, including pedestrians, and is barricaded at both ends. The larger trusses have been stiffened by adding turnbuckle cables where the diagonal braces and counters have slackened or parted, and the latticing of one of the web struts has been replaced by intermittent welded plates. The asphaltic wearing surface of the deck is badly deteriorated and the timber floor has rotted through at several locations. Except for these alterations, the bridge is substantially unaltered from the time of its construction.

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[2]Victor Darnell, "Lenticular Bridges from East Berlin, Connecticut," IA, Vol. 5, No. 1 (1979): 23. Darnell states that both timber and 6" and 7" iron stringers were used. Also, a drawing of the Old Corinth Road Bridge dated December 1910 in the files of the Saratoga County Department of Public Works, Ballston Spa, New York, shows these elements to be in place at that time.

II. HISTORY OF THE BRIDGE

A. Construction and Alteration

The Old Corinth Road Bridge was erected in 1885 to replace a covered timber bridge that had carried traffic between the hamlet of Hadley and the village of Corinth (then Jessups Landing), in the Town of Hadley, Saratoga County, New York. The road between Hadley and Corinth was part of a network of routes that linked strings of communities which developed along the Hudson and Sacandaga rivers where the two emerge from the southeastern portion of the Adirondack Mountains. The area was settled during the last decades of the eighteenth century, initially by farmers migrating westward from Vermont or northward up the Hudson River valley in search of inexpensive land, and eventually by businessmen who created a variety of industries supported by the vast timber resources of the northern forest.[3]

On September 10, 1885, the Board of Auditors of the Town of Hadley authorized John Holleran, the Town's Commissioner of Highways, to:

> ...proceed at once to build at the expense of said town a good and substantial iron bridge at and upon the site of the late Sacandaga Bridge.[4]

The new bridge was needed to replace what had undoubtedly been the first structure at that crossing, a "double-barrel" covered timber arch built in 1813 under the supervision of Obadiah Wilcox.[5] That first bridge had been destroyed by fire

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[3]N. B. Sylvester, History of Saratoga County, New York (Philadelphia: Everts & Ensign, 1878), 414-421; also, V. B. Dunn, ed., Saratoga County Heritage (Saratoga County, New York: 1974), 608.

[4]Town of Hadley, Town Meeting minutes, 10 September 1885. Office of the Town Clerk, Hadley, New York.

[5]The original bridge is described by R. S. Allen, Old North Country Bridges (Utica, NY: North Country Books, 1983), 84. The builder's identity is given by Sylvester, History of Saratoga County,

earlier in the year and the new bridge was to be seated on the same abutments and pier, repaired and extended to raise the elevation of the roadway. Construction was to be by contract to the lowest bidder.[6] At a special meeting on September 26, 1885, the town's eligible voters supported a proposition to rebuild the bridge by a vote of sixty-two to forty-one.[7] The wrought and cast iron superstructures were fabricated and erected by the Berlin Iron Bridge Company of East Berlin, Connecticut. Neither the identity of the other bidders nor the amount of the successful bid survive.

Why the Connecticut company chose a bridge with such an unusual truss configuration is, likewise, not recorded. However, reflection on some general engineering considerations regarding truss design does suggest a plausible, if not complete, explanation. There is a proportional relationship between the unsupported length of a truss and the depth of the truss at center span needed to limit deflection at that point to some predetermined acceptable value. In simpler terms, all else being equal, the longer the truss, the greater the depth required. In shorter spans, the trusses are shallow enough to stand unsupported (as in pony trusses), but in longer spans they require bracing against lateral buckling, most commonly accomplished by placing struts between opposing panel points of the upper chords (as in through trusses). The relationship does not hold precisely because all else, in fact, is not equal. The configuration of the particular truss, sizing of its individual members, and the expected loads are all mitigating factors.

Spans of intermediate length, like the bridge at Hadley, pose particular design problems, for while their trusses may be deep enough to require lateral bracing, they may also be too

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415, and repeated by Allen.

[6]Town of Hadley, meeting minutes, 10 September 1885. Extension of abutments and pier can be seen by comparing photographs of the new bridge (Victor Darnell collection) with the old (Allen, Old North Country Bridges, 84).

[7]Town of Hadley, meeting minutes, 26 September 1885.

shallow to permit adequate clearance beneath the bracing. The problem is aggravated with parabolic trusses, compared to those with parallel chords, because the arch of the upper chord may preclude carrying the bracing all the way to the end posts. The problem can be solved, regardless of the truss type, by redesigning the upper chords to increase their lateral stiffness, increasing the depth of the trusses to accommodate the clearance requirement, or by a combination of these two solutions. However, with parabolic trusses, two other options were available, and the Berlin Iron Bridge Company exercised both options.[8] One was to limit overhead bracing to the interior panels that were high enough to meet the clearance requirement. The other was to lower the trusses so that they could be braced by the floor beams or, in longer spans, by both the floor beams and lateral struts beneath the deck. The latter option would have been viable only when sufficient clearance existed beneath the bridge. The specific conditions under which any of these solutions were used by the Berlin company are not known, but it must be assumed that the one to prevail was that which could be erected at a particular site for the least total cost, and still meet all of the structural requirements.

What is seen in the main span of the Hadley bridge, then, can be interpreted as the solution to a design problem that was imposed by the requirement to make use of the abutments and pier surviving from the pre-existing bridge. Presumably, the builder had the option of bridging between the existing abutments with a single 180-foot span, which surely would have required a high truss with full overhead bracing, or extending the pier and building two shorter spans. It is assumed that the latter option was used because it was the least costly, particularly when further savings could be realized by lowering the trusses of the main span, simultaneously solving the lateral stiffness problem and eliminating the need for end posts and other portal details.

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[8]Darnell, "Lenticular Bridges from East Berlin, Connecticut," 22 and 25. Also, The Berlin Iron Bridge Company, East Berlin, Connecticut, U.S.A., undated catalogue c. 1888: 19, 21, 23 and 25. Six different bridges (seven spans) are illustrated in the catalog, all in this "awkward" range between 85' and 150'.

In 1885, the Hadley-Corinth road, including its bridges, was owned and maintained by the jurisdictions through which it passed, the Towns of Hadley and Corinth. However, as highways became increasingly important to the economy and social life of the region and the nation, greater attention was given to the construction and maintenance of good roads at all levels of government. Thus, in 1907 the Corinth-Hadley road was included in a new system of county highways established by direction of the New York State legislature. This system was aimed at channeling more funds into local highway improvements by creating a basis for the state to give higher priority to such funding.[9] In 1912 the county road system was incorporated into a state system to be funded entirely by New York State under the supervision of a new State Superintendent of Highways.[10] Notwithstanding, ownership of the bridges themselves remained with the local jurisdictions until 1926 when the state was authorized to take over all bridges on the state highway system formerly built and owned by the counties and towns. With the bridging of the Hudson River south of Hadley and Lake Luzerne in 1932, a new state-controlled bypass was created. The end result was that the portion of the Hadley-Corinth road (Rte. 9N) that passed through the hamlet of Hadley and included the Old Corinth Road Bridge was abandoned by the state and returned to the town's jurisdiction.[11]

Other than periodic replacement of the timber deck, there is no evidence of significant alterations to the bridge before that time. The first major changes came in 1972. At that time, the bridge, then posted for 3 tons, was closed because it was deemed

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[9]Chapter 715, Laws of 1907.

[10]Chapter 30, Laws of 1909, and amendments.

[11]Road Histories, Corinth-Hadley, SH815; unpublished records of the Highway Maintenance Division, New York State Department of Transportation. Also, "Chronology of New York State Highways," typescript prepared by the Division of Highways, New York State Department of Public Works, 19 October 1943. The chain of ownership of the Old Corinth Road Bridge to 1972 has been inferred from these documents and files of the Saratoga County Department of Public Works.

unsafe to carry the additional traffic anticipated due to the temporary closing and rehabilitation of the newer Rte. 9N bridge below Lake Luzerne. Due in large measure to local pressure, emergency repairs were made to the trusses (noted in Section IIB, above), the bearings were rebuilt, and the bridge was reopened to one-vehicle-at-a-time, 10 mph traffic, which was confined by timber curbs to a single 14' travel width.[12] The bridge was finally closed to all traffic, including pedestrians, in 1983.[13]

B. William O. Douglas and The Berlin Iron Bridge Company

The Old Corinth Road Bridge, built by the Berlin Iron Bridge Company, is based on an 1878 patent granted to William O. Douglas, a hardware wholesaler from Binghamton, New York.[14] Douglas was born in Cortlandville, New York in 1841, attended local schools, and in 1861 entered the U. S. Military Academy at West Point, New York. Upon the outbreak of the Civil War, he was assigned to the Fourteenth Infantry of the Army of the Potomac, saw action in a number of major battles, and was wounded at Gettysburg. After a short stint with the Reconstruction Bureau in Texas, he was retired with the rank of Captain. In 1869, he moved to Binghamton and, with a partner, entered the wholesale

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[12]John W. Strohl, Acting County Superintendent, Saratoga County Highway Department, to Supervisor and Superintendent of Highways, Town of Hadley, "Official Order Closing Corinth Road Bridge (Town of Hadley Bridge No. 142)," 15 November 1972. Also, John W. Strohl to the Hadley Town Board,"Report on Old Town of Hadley Bridge (Bridge No. 142)", typescript, 26 December 1972. Office of the Town Clerk, Hadley, New York.

[13]"Crippled Crossing," Post-Star, Glens Falls, New York, 22 October 1986. Also, Parabolic Bow String Bridge Remediation: NYSDOT ISTEA Program Application. Report prepared for the Town of Hadley Board of Trustees, Saratoga County, New York by C.T. Male Associates, P.C., 3 June 1994).

[14]William O. Douglas, U.S. Patent No. 202,526, April 16, 1878.

hardware business.[15]

In 1877, Douglas sold his interest in the hardware business and soon thereafter affiliated with the Corrugated Metal Company of East Berlin, Connecticut, a manufacturer and fabricator of corrugated iron for buildings. The company, founded in 1870 as The Metallic Corrugated Shingle Company was now on the verge of bankruptcy and thus being reorganized by its new president, S. C. Wilcox. Wilcox contracted with Douglas for the manufacture and sale of Douglas' patent truss bridges and hired Douglas as his treasurer and executive manager. By 1883, iron bridges had become such a dominant part of the now prospering business that the name was again changed, this time to The Berlin Iron Bridge Company. When Wilcox died in 1886, the company's chief engineer, Charles M. Jarvis, became the new president, retaining that position until 1900 when the company, along with twenty-five others, was merged into the American Bridge Company. Douglas, who had maintained his home in Binghamton, returned to that city soon after Wilcox's death but retained his affiliation with the Berlin company as a sales agent.[16]

E. L. Kemp has probably offered the simplest lay explanation of how the parabolic truss works by describing it as a "form of self-anchored suspension bridge."[17] Using this analogy, tension developed in the eye-bar "chain" that forms the lower chord, and which in a true suspension bridge would require anchored back stays, is balanced by the horizontal thrust of the arched upper chord. Or, conversely, it could be described as a "self-braced arch" in which the horizontal thrust of the arch is balanced by tension in the chain rather than by abutments or a horizontal

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[15]Biographical Review: Broome County, New York (Boston: Biographical Review Publishing Company, 1894): 183-185.

[16]"The Berlin Iron Bridge Company," East Berlin (Conn.) Mirror, 5:1 (December 1895): 9-10; Robins Fleming, "Early Parabolic Truss Bridges Gradually Disappearing," Engineering News-Record 100 (10 May 1928): 748-749; and Darnell, "Lenticular Bridges," 24.

[17]E. L. Kemp, "The Fabric of Historic Bridges", IA, Vol. 15, No. 2 (198): 12-13.

tie. From the perspective of engineering mechanics, the parabolic truss also (using Kemp's words) "dramatically illustrates that an arch and the suspension chain are the inverse of one another." By this he means that the chain, when loaded at its pins, drapes in a parabolic curve that is a mirror image of the arch, when the pins of the arch are positioned on a parabola.

That this complementary action was understood by Douglas is clear from the wording of his patent in which he noted that, "the thrust of the top chord ... is resisted by the pull of the lower chord...." and, in fact, it became an important theme in subsequent literature promoting the parabolic truss.[18] For instance, the introduction to one of the bridge company's catalogues, dated about 1889 and probably written by Jarvis, made the following argument regarding the relationship of these structural elements:

> Unite these two at the ends, one to resist the other, and you have the strongest form of truss.[19]

It has been pointed out by many that the parabolic truss did not originate with Douglas. There were precedents in France (1840), Germany (1857), and England (1859), and two patents were issued to American inventors between 1851 and 1855.[20] Victor Darnell, an authority on Douglas and the Berlin Company, believes that Douglas conceived his design without prior knowledge of earlier usage or patents.[21] One might expect Douglas to have known of these precedents given his training at the U.S. Military Academy where, in 1861, much of the engineering instruction would still have been based on European practice and given his obvious

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[18]William O. Douglas, U.S. Patent No. 202,526, April 16, 1878.

[19]The Berlin Iron Bridge Company Catalog: 4.

[20]See Darnell, "Lenticular Bridges," 19; C. W. Condit, American Building Art, Vol. 1 (New York: Oxford University Press, 1960): 125-127; and H. G. Tyrrell, History of Bridge Engineering, (Chicago: published by author, 1911): 172-173.

[21]Darnell, "Lenticular Bridges," 27.

understanding of the engineering basis for his design as revealed in his patent description. However, Darnell argues that Douglas was transferred from West Point to active duty in 1862, the year following his admittance, and therefore may have received as little as one year's instruction.[22] Further, the engineering texts that would have been available to him (Mahan's Civil Engineering, Haupt's General Theory of Bridge Construction, etc.) neither mentioned nor illustrated the lenticular truss.

III. SIGNIFICANCE OF THE BRIDGE

The Old Corinth Road Bridge is representative of a period of American bridge building in which the shop-fabricated/field-erected metal truss was the dominant structural form of highway crossings in most parts of the country. Components were assembled at centralized locations from standard mill sections and transported by rail, canal and wagon to designated sites where they were erected to the specifications of local highway commissioners, typically in response to invitations for competitive bids. By the early 1880s, iron had yielded to steel as the preferred structural metal and a limited number of "standard" truss forms had evolved from what a few years before had been a period of unbridled experimentation. The industry after 1880 was dominated by strong regional or national companies that marketed through networks of agents and illustrated catalogs that included testimonials from satisfied customers.

The Berlin Iron Bridge Company was one of these regional companies and was particularly successful in New England and New York State. It was typical of its competitors in many respects, but was unique in the degree to which it was able to market its proprietary designs during this period of standardization, and uncommon in its persistent use of wrought iron for the structural members of its bridges. In these regards, the iron parabolic trusses built by the Berlin company were an anachronism. Their success, which has been attributed variously to aggressive promotion and to the economy inherent in their design, continued

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[22]Victor Darnell, interview with author, n.d.

until the mid-1890s.[23] The Old Corinth Road Bridge is an excellent example of this important company's products and provides a rare opportunity to see two forms of the parabolic truss at the same location.

All parabolic trusses illustrate, better than any other structural form, the important relationship between the arch and the suspension chain. Except for the unusual positioning of its main span trusses with respect to its deck, which required modifying the typical web design, the two spans of the Old Corinth Road Bridge vary little from the company's other parabolic designs. That distinctive feature is interpreted as an economical alternative to overhead bracing, one that could be used with parabolic trusses of intermediate span when sufficient clearance below the truss was available, but not with the other dominant forms. In spite of the striking visual impact of the semi-deck form, it is known to have been used in only two other instances, a frequency that likely reflects the rare occurrence of conditions requiring a span of mid-length over a channel deep enough to allow the truss to be lowered.[24]

The Old Corinth Road Bridge is one of well over 600 built by the Berlin Iron Bridge Company. Forty-eight surviving Berlin bridges were identified in 1979.[25] The bridge has been featured in a variety of publications of national circulation since 1928 and is well known among historians of bridge technology. Known locally as the Bow Bridge, it was listed in the National Register of Historic Places in 1977.[26]

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[23]Darnell, "Lenticular Bridges," 27; Kemp, "Fabric of Historic Bridges," 11; and D. Plowden, Bridges - The Spans of North America (New York: The Viking Press, 1974): 66-67.

[24]One each at Highland, New York, 103' long, and Iona Island, New York, 105' long. Victor Darnell, personal correspondence with author.

[25]Darnell, "Lenticular Bridges," 24-31.

[26]Certificate of listing, National Register of Historic Places, United States Department of the Interior, 25 March 1977.

In recognition of its historical and engineering significance, the Town of Hadley was awarded a $275,800 grant by the New York State Department of Transportation in 1994 to rehabilitate the Old Corinth Road Bridge and return it to service as a pedestrian and bicycle crossing. However, the grant, funded under the Transportation Enhancement Program of the federal Intermodal Surface Transportation Efficiency Act (ISTEA), was declined because the Town could not fund the local share of $68,950.[27] In 1998, a citizen's group began raising money for further engineering study and is hoping to reapply for ISTEA or other grants to fund the rehabilitation of this remarkable bridge.

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[27]Diane Hastings, Town Clerk, Town of Hadley, Saratoga County, New York, interview with author.

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Hastings, Diane, Town Clerk, Town of Hadley, Saratoga County, New York. Interview by author, n.d.

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All color xeroxes were made from a duplicate color transparency.

Jet Lowe, Photographer, Summer 1994.

NY-292-14 (CT)	OLD CORINTH ROAD BRIDGE TAKEN FROM UPSTREAM RAILROAD BRIDGE, LOOKING EAST.
NY-292-15 (CT)	OLD CORINTH ROAD BRIDGE TAKEN FROM RIVER LEVEL, LOOKING SOUTHEAST.