United States Department of the Interior
National Park Service

National Register of Historic Places
Multiple Property Documentation Form

This form is used for documenting multiple property groups relating to one or several historic contexts. See instructions in *How to Complete the Multiple Property Documentation Form* (National Register Bulletin 16B). Complete each item by entering the requested information. For additional space, use continuation sheets (Form 10-900-a). Use a typewriter, word processor, or computer to complete all items.

X New Submission __ Amended Submission

A. Name of Multiple Property Listing

COVERED BRIDGES NHL CONTEXT STUDY

B. Associated Historic Contexts

C. Form Prepared by

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D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR Part 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation. (See continuation sheet for additional comments.)

Signature and Title of Certifying Official — Date

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I hereby certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Signature of the Keeper — Date

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E. STATEMENT OF HISTORIC CONTEXTS

Covered bridges are a pre-eminently American phenomenon. Nowhere else in the world were such impressive timber bridges attempted, and nowhere else were they built in such vast numbers.[1] Over the course of two centuries, covered bridges have played a significant role in American life, by facilitating settlement, transportation, and commerce. They also represent a period of remarkable achievement in civil engineering, during which bridge building evolved from an empirical craft to a science. At the height of covered bridge building, around 1870, there were well over 10,000 covered bridges in the United States.[2]

Timber bridges have been built in forested regions of the world for centuries.[3] Wood is an excellent material for building; it is strong, relatively lightweight, and easy to work with. Since most species of wood suitable for structural applications deteriorate rapidly when exposed to the weather, bridge builders quickly learned the value of covering wood bridges with roofs and siding to protect the underlying framework.[4] Several European covered bridges have survived for more than three centuries, while a few in the United States are nearing the two-century mark.[5]

Following the American Revolutionary War, the demand for roads and bridges, coupled with access to abundant forests, spurred the independent development of timber bridge design in the United States.[6] In 1805, America's first known covered bridge was completed across the Schuylkill River at Philadelphia. By 1810, there were covered bridges at most major river crossings in the Northeast. From Philadelphia, covered bridge building spread northward, southward, and westward at a rapid pace. The construction of timber bridges utilized readily available materials and common hand tools. Skilled carpenters could erect an average-sized covered bridge within a few weeks. By 1850, there were covered bridges in most settled regions of the United States.

The golden era of covered bridge building lasted about a century in most areas of the United States, and even longer in areas where timber was plentiful.[7] In the late-nineteenth century, timber truss bridges were eclipsed by comparable spans of iron. Railroads enabled manufacturers to ship prefabricated metal bridges to distant markets and compete with local builders for contracts. The last decade of the nineteenth century saw the rise of the Good Roads Movement and growing demand for modern bridges, a trend that gained momentum with the advent of the automobile.

In the face of the technological and industrial advances of the first decades of the 1900s, covered bridges, now traversed by motorized vehicles or glimpsed from modern highways, generated powerful feelings of nostalgia for many Americans. In the 1930s, covered bridges emerged in popular culture. During this period, antiquarians and hobbyists also set out to visit, photograph, and gather information about those structures that survived. Collecting images and information about these historic structures led to the formation of covered bridge societies in the 1940s. As this movement gained momentum in the 1950s and 60s, local and state officials began to promote covered bridges as tourist attractions to boost their local economies.

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[1] American scholars have recently become aware of hundreds of ancient covered bridges in China; however, most of these bridges were built for pedestrian use and their construction techniques and reason for covering differ from the Western tradition.

[2] This is only a rough estimate of known covered bridges that existed c.1870. Initial data compiled by the “Covered Spans of Yesteryear Project,” http://www.lostbridges.org, suggests that this figure may be too low.

[3] In 55 BC, Julius Caesar (100 BC-44 BC) built the world’s first major timber bridge across the Rhine River near present-day Koblenz, Germany.

[4] It is believed that this practice originated in Switzerland.

[5] Hyde Hall Bridge (1825) is believed to be the oldest covered bridge in the United States. See HAER No. NY-330, Hyde Hall Bridge, Otsego County, New York.

[6] While it is likely that American builders were aware of covered bridges in Europe, there is very little documentation to suggest a direct transfer of knowledge from Europe to America.

[7] Covered bridge building persisted longer in different regions. For example, it ended in New England around 1920, in the Midwest around 1925, and in the South around 1935. Covered bridges continued to be built in Oregon into the 1950s.

By 1970, the tide was beginning to turn in favor of preserving covered bridges. Though many continued to be lost to floods, fires, structural failure and vandalism, fewer were destroyed in the name of progress, and many became the objects of intensive preservation efforts. Today, there are approximately 690 historic (pre-1955) covered bridges in the United States.[8]

EARLY AMERICAN BRIDGES

Bridges were rare in Colonial America. Small streams were spanned with logs or stone slabs, and occasionally with stone arches, but with few exceptions, major waterways had to be crossed by ford or ferry. Travel was hazardous and uncertain; delays and accidents were common.[9] A few ambitious crossings were made with a series of simple beam spans supported on timber piles, but long-span bridges were generally not built until after the American Revolutionary War, when the growing volume of transportation justified the expenditure of material and labor.[10]

The first era of American bridge building began in 1785, when Col. Enoch Hale (1733-1813) of Rowley, Massachusetts erected the nation's first long-span framed timber bridge across the Connecticut River between Walpole, New Hampshire and Bellows Falls, Vermont. Heralded as a great engineering achievement, Hale's 360-foot braced beam span was supported on rubble stone abutments and a timber pier rising from a small island in the middle of the river. The *Massachusetts Spy* stated, "Col. Enoch Hale hath erected a Bridge across Connecticut River, on the Great-Falls, at his own expense. This bridge is thought to exceed any ever built in America, in strength, elegance and publick utility."[11] Although Colonel Hale's bridge successfully carried traffic for a decade, its design was uniquely suited to this site and could not be easily replicated elsewhere.

Creating spans greater than the length of a single log or beam was one of the initial challenges facing timber bridge builders and this required construction of a frame structure known as a truss. The truss, which utilizes the stable geometry of the triangle to carry a load, is the most efficient way to build long spans of wood. Trusses have been used for centuries for centering masonry arches and for roof construction. The truss came into use in European bridge building in the Middle Ages. Italian architect Andrea Palladio (1518-1580) popularized the concept of truss bridges in his influential treatise, *The Four Books of Architecture*.[12]

In 1792, Massachusetts housewright Timothy Palmer (1751-1821) erected America's first long-span timber truss bridge across the Merrimac River at Newburyport, Massachusetts.[13] Containing over 6,000 tons of lumber, the 1,030-foot Essex Merrimac River Bridge had two innovative "trussed arch" spans, measuring 113 and 160 feet long, which one writer described as follows: "The two large arches (one of which is superior to any thing of the kind on the continent) … appear to unite elegance, strength and firmness beyond the most

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[8] The *World Guide to Covered Bridges* (2009) includes dozens of modern covered bridges built in the United States after 1954. Some of these are authentic covered bridges (i.e. bridges having wood load-bearing members and built using traditional framing techniques) and some are not. The distinction between historic (pre-1955) covered bridges and modern covered bridges is that all covered bridges built since 1954 were built, in part, for sentimental reasons, rather than purely economic reasons.

[9] Isaac Weld, Jr. describes the challenges of overland travel in *Travels Through the States of North America and the Provinces of Upper and Lower Canada During the Years 1795, 1796 and 1797* (London: John Stockdale, 1807).

[10] The Great Bridge (1662) across the Charles River at Cambridge, Massachusetts and Sewall's Bridge (1761) across the York River at York, Maine, were notable exceptions. Both bridges consisted of a series of simple beam spans. The Great Bridge was supported by stone-filled log cribs, while the York River Bridge used timber pile trestles.

[11] *The Massachusetts Spy, or, American Oracle of Liberty*, [Worcester, Massachusetts], 10 February 1785.

[12] Andrea Palladio, *The Four Books of Architecture* (London: Isaac Ware, 1842), Third Book, plates III-V. *I Quattro Libri dell'Architettura* (*The Four Books of Architecture*) was published in Italy in 1570; the first English version was published in London in 1716-1720.

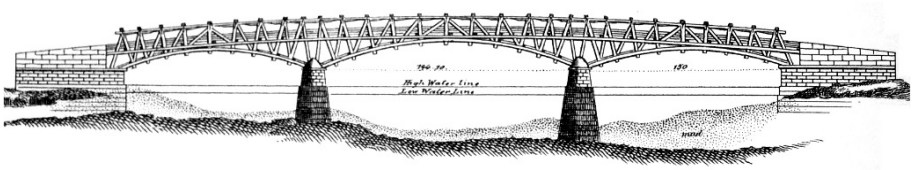
[13] John Bliss's Leffingwell Bridge (1764) at Norwich, Connecticut, described as being "*supported by Geometry work above*," *may* have been the first use of the truss principle in American bridge design, but the Essex Merrimac River Bridge was the first *long-span* truss bridge in the United States.

sanguine expectation."[14] This structure represented a quantum leap forward in timber bridge design and brought the builder much acclaim. Over the next thirteen years, Palmer erected 10 major bridges in the Northeast.

AMERICA'S FIRST COVERED BRIDGE

In the late-eighteenth century, Philadelphia was the largest and wealthiest city in the United States, but it had few bridges spanning its major waterways. A stone arch bridge had carried the King's Highway across Pennypack Creek for a century,[15] but the deep and fast-flowing Schuylkill River posed a much greater challenge, as one nineteenth-century writer noted: "The character of this river is wild, and, in times of floods, rapid and formidable; and, to any structures of slight materials, ruinous and irresistible."[16] Ferry service was established in 1723, but it was often slowed or stopped entirely by inclement weather, floods, or ice. During the late-nineteenth century, several rudimentary floating bridges were constructed to supplement ferry service, but they, too, were less-than-ideal solutions to crossing the Schuylkill River.

In 1798, a group of forward-thinking citizens, led by Richard Peters (1744-1828), incorporated the Schuylkill Permanent Bridge Company for the purpose of erecting a toll bridge over the Schuylkill River near the city center. The board of directors originally hired British engineer William Weston (1763-1833) to build a stone bridge, but construction of the foundations proved so costly that, within a few months, the company was forced to consider alternative plans. Weston then designed an iron bridge for the crossing, but the board of directors was reluctant to attempt such a large span with the relatively untested material. After consulting with Timothy Palmer, at that time the nation's preeminent bridge builder, the directors opted to build a timber structure on stone foundations. In the spring of 1804, Palmer and his assistant, Samuel Carr (b.1740), traveled to Philadelphia to erect the bridge superstructure. A 195-foot trussed arch center span flanked by two 150-foot trussed arch spans slowly rose from the foundations. Heralded as an engineering masterpiece and "an honour to its inventor for its originality of architecture, and its excellence of mechanism,"[17] the Schuylkill Permanent Bridge was opened to traffic on January 1, 1805.[18]



SCHUYLKILL PERMANENT BRIDGE. Thomas Pope, *A Treatise on Bridge Architecture* (1811).

Due to the extraordinarily high cost of construction—$300,000—the board of directors corresponded with Palmer about the feasibility of covering the structure to protect it from the weather. In his reply, Palmer affirmed the board's decision with this statement: "It is sincerely my opinion that the Schuylkill bridge will last thirty and

[14] "Description of the Essex Merrimack River Bridge," *The Massachusetts Magazine*, May 1793.

[15] Built in 1697, the Pennypack Creek Bridge is the oldest extant roadway bridge in the United States. See HABS No. PA-1786 and HAER No. PA-465, Pennypack Creek Bridge, Philadelphia County, Pennsylvania.

[16] Richard Peters, *A Statistical Account of the Schuylkill Permanent Bridge Company, Communicated to the Philadelphia Society of Agriculture* (Philadelphia: Jane Aitken, 1807), 6.

[17] Fortescue Cuming, *Sketches of a Tour to the Western Country, 1807-1809* (Pittsburgh: Cramer, Spear & Eichbaum, 1810), 25.

[18] In 1840, the City of Philadelphia purchased the Schuylkill Permanent Bridge for $80,000; that bridge was destroyed by fire in 1850. The second covered bridge at this site stood until 1875, when it, too, was destroyed by fire. The third covered bridge at this site stood until 1888, when it was replaced with an iron structure. The present bridge (Market Street Bridge) is a concrete structure erected in 1932.

perhaps forty years, if well covered. ...I think it would be sporting with property to suffer this beautiful piece of architecture…which has been built at so great expense and danger, to fall into ruins in 10 or 12 years!"[19]

The company directors hired Philadelphia stone cutter Adam Traquair (b.1780) and architect Owen Biddle (1774-1806) to cover the bridge, stating that the housing "compelled ornament, and some elegance of design, lest it should disgrace the environs of a great City."[20] In addition to its numerous architectural embellishments, including sculptures by artist William Rush (1756-1833), the structure was given two coats of ornamental stone plaster and sprinkled with stone dust to resemble a stone bridge. Speaking for the board of directors, Judge Peters stated that this bridge would serve as an example "in all pontifical wooden structures of magnitude, hereafter."[21] Other bridge builders soon subscribed to the convention. By 1810, adding a roof and siding to timber bridges was a common option in America.[22]

PROLIFERATION OF COVERED BRIDGES

> It is a notorious fact that there is no country of the world which is more in need of good and permanent bridges than the United States of America. Extended along an immense line of coast on which abound rivers, creeks and swamps, it is impossible that any physical union of the country can really take place until the labours of the architect and mechanic shall have more perfectly done away the inconvenience arising from the intervention of the waters. Nature, ever provident for man, has, however, afforded us ample means of remedy. Our forests teem with the choicest timber; and our floods can bear it on their capacious bosoms to the requisite points.
>
> -Thomas Pope, *A Treatise on Bridge Architecture* (1811).

Internal improvements were one of the first priorities of the new nation. Roads, canals, and bridges were desperately needed to expand commerce and unite the country. The Louisiana Purchase of 1803 doubled the land area of the United States and over the next half-century, settlement expanded west to the Pacific Ocean. Timber bridges were an ideal solution to America's many transportation hurdles and hundreds of them were constructed as the frontier was pushed westward. They provided for the safe, efficient and economical overland transportation essential to the new nation's growth.

Covered bridges were adapted to the needs of all types of transportation corridors, including turnpikes, canals and railroads. The rapid growth of the railroads in the mid-1800s—in particular, the increasing weight of locomotives and rolling stock—encouraged technical advancements in the design of timber truss bridges and was an important factor in the rise of civil engineering as a profession.

By 1850, there were covered bridges in most settled regions of the United States.[23] Thereafter, the number of covered bridges continued to multiply until about 1870, by which time there were well over 10,000 covered bridges throughout the country.[24] Areas where covered bridges were not built include the heart of the Rocky Mountains, the Northern Plains, the Southern Plains, Louisiana, and Florida.

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[19] Peters, 49.
[20] Ibid., 34.
[21] *Ibid.*
[22] Timothy Palmer's Easton Bridge (1805), spanning the Delaware River at Easton, Pennsylvania, was designed as a covered bridge from the beginning and many of his earlier bridges were subsequently housed.
[23] Fred Kniffen, "The American Covered Bridge," *The Geographical Review* 41 (1951), 118-119.
[24] Covered bridges once existed in 41 of the 50 states. No records have been found of historic covered bridges existing in Colorado, Florida, Idaho, Louisiana, New Mexico, North Dakota, Oklahoma, South Dakota and Utah. Only recently has it come to light that in Hawaii there were at least two.

The reasons for this presumably vary from region to region, but may include: lack of readily-available timber, lack of major river crossings, topographical and geological conditions more suited to other types of bridges, late-period settlements and low population density.

TIMBER BRIDGE TECHNOLOGY

All bridges can be categorized as one of five structural types: beam, arch, truss, cantilever or suspension. Each type has advantages and disadvantages and each is best suited for particular materials and site conditions. Timber bridges can be one of the first four types, but the truss is the most efficient way to built long spans of wood, so most covered bridges (more than 98 percent) are truss bridges. In general, only arch bridges and truss bridges need to be covered, because the placement of the structural members leaves them exposed to the elements, so arches and trusses are the main types represented in the covered bridge population.[25]

Arch Bridges. The defining characteristic of an arch is its reliance on compression to carry loads. To successfully build an arch bridge of wood, the arch has to be braced so that it will maintain its shape under loading. Combining an arch with a truss is one way to do this. The pure arch timber bridge is a distinct subgroup that includes "tied" arches and "polygonal" arches.

In a tied arch, the arch is made up of layers of plank (i.e. laminated) that fit into slots in the outer ends of the bottom chord; the bottom chord ties the ends of the arch together, resisting the horizontal thrust that would otherwise necessitate substantial abutments. Tied arch bridges are economical because they don't rely on heavy masonry or truss framing, but their relative lack of stiffness makes them suitable only for short spans.[26] The tied arch was never part of the mainstream of timber bridge building, but was part of a regional tradition in Vermont, where three such covered bridges survive.[27]

In a polygonal arch, the arch is made up of short segments of wood butted end-to-end (i.e. segmented) and braced within a series of rectangular panels. The polygonal arch was never part of the mainstream of timber bridge building, but was part of a regional tradition in Virginia, where three such covered bridges survive.[28]

Truss Bridges. The vast majority of covered bridges are truss bridges. A truss is an assemblage of relatively small members, usually combined in a series of triangles, to form a rigid framework capable of supporting a load over a relatively long distance.[29] Trusses carry loads by alternately pushing and pulling the individual members. They can be categorized by the arrangement of those members.

Several types of trusses have been used since the Middle Ages and many more were invented by nineteenth-century bridge builders, although only a few of the latter entered the mainstream of covered bridge building. These will be discussed on the next few pages.

Truss bridges can also be categorized by the location of the deck in relation to the trusses. The vast majority of covered bridges are through truss bridges, which have full-height trusses with overhead bracing and the deck

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[25] The New Portland Wire Bridge (1866) in Somerset County, Maine, is a unique structure listed in the *World Guide to Covered Bridges*. It is the only extant suspension bridge with covered wood towers in the United States. See HAER No. ME-3, New Portland Suspension Bridge, Somerset County, Maine.

[26] See HAER No. VT-36, Swallow's Bridge, Windsor County, Vermont.

[27] The tied arch design was used much more extensively for iron bridges. In 1841, bridge builder Squire Whipple (1804-1888) became the first of at least 10 individuals to patent designs for arched truss bridges made of iron. Commonly known as a "bowstring" truss, this bridge type was favored for iron spans up to about 150 feet from about 1850 to 1890. By the late-nineteenth century, this design gave way to the more easily standardized truss types.

[28] See HAER No. VA-126, Sinking Creek Bridge, Giles County, Virginia. A few non-housed polygonal arch wood bridges were built during World War II; one such bridge still stands at Arlington, Vermont.

[29] Trusses are usually made up of interconnected triangles because a triangle is very stable (i.e. it is the only polygon that is unalterable without changing the length of one of the sides, or the angles formed by the sides).

is carried at the bottom chords. Pony truss bridges are an economical way to build shorter spans, because the trusses don't need to be as deep. Timber pony truss bridges commonly had each truss housed separately, leaving the deck uncovered, to allow for the passage of vehicles. There are presently only six known pony truss covered bridges in the United States.[30] Deck truss bridges, in which traffic is carried on top of the trusses, are economical for sites with high embankments, because they require shorter piers. Deck truss bridges were most often used for railroad spans. There is only one extant deck truss covered bridge in the United States.[31]

ANCIENT TRUSS TYPES

Most of America's early bridge builders based their designs on simple trusses that have been used for roof framing and bridges since the Middle Ages, specifically the kingpost, queenpost and multiple kingpost truss. Some bridge builders used these trusses directly and others took them as a point of departure in developing more complex timber bridge designs.

Kingpost Truss. The kingpost truss is the oldest and most basic truss form. It is essentially a triangle, consisting of a bottom chord and two diagonal braces. The diagonal braces, by working in compression, act to support the upper end of the kingpost, which, in turn, works in tension to support the deck at mid-span. The kingpost truss is generally used for short spans of between 20 to 60 feet. It was widely used for non-housed timber bridges as well as covered bridges. There are 18 extant historic (pre-1955) kingpost truss covered bridges in the United States (the majority are located in Pennsylvania and Vermont), with dates ranging from c.1850 to 1943.

Queenpost Truss. The queenpost truss is a variation of the kingpost truss that was developed to span longer distances, of about 40 to 90 feet. It consists of a horizontal top chord between two vertical posts supported by two diagonal braces that are tied together by a horizontal bottom chord. The bottom chord and posts act in tension and the diagonal braces act in compression under loading. There are approximately 80 extant historic (pre-1955) queenpost truss covered bridges in the United States (the majority are located in Pennsylvania and Vermont), with dates ranging from 1835 to 1932.

Multiple Kingpost Truss. The multiple kingpost truss has multiple braced panels flanking the central kingpost. It is used for spans of approximately 50 to well over 100 feet and is the basic truss used in the Burr truss system. There are approximately 90 extant historic (pre-1955) multiple kingpost truss covered bridges in the United States (the majority are located in Ohio), with dates ranging from 1832 to 1947.

DEVELOPMENT OF TIMBER TRUSS BRIDGES IN AMERICA

> It is in timber work that the Americans excel, and … it is their timber structures which are most interesting to British engineers, who have ample opportunity of studying stone and iron bridges at home. To any engineer about to practice in a new country, the study of the American timber bridges is invaluable, as showing what gigantic and useful works may be constructed with that material.
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> -David Stevenson, *A Sketch of the Civil Engineering of North America* (1838).

The first half of the nineteenth century saw a great technological advancement in the design and construction of timber bridges in America. Between 1790 and 1840, timber bridge forms evolved from rudimentary pile-and-beam spans to scientifically designed, long-span trusses capable of carrying railroad loadings. The demand for

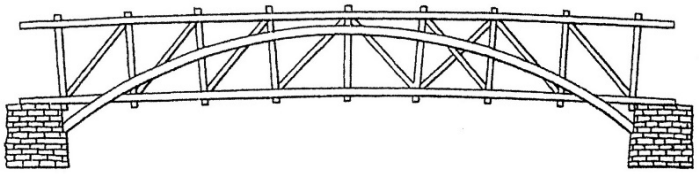
[30] See HAER No. NH-43, Livermore Bridge, Hillsborough County, New Hampshire; HAER No. NH-44, Rollins Farm Bridge, Strafford County, New Hampshire; HAER No. NH-48, Boston & Maine Railroad, Berlin Branch Bridge #143.06, Coös County, New Hampshire; HAER No. NH-49, Boston & Maine Railroad, Berlin Branch Bridge #148.81, Coös County, New Hampshire; and HAER No. PA-623, Burnt Mill Bridge, Bucks County, Pennsylvania.

[31] See HAER No. NH-36, Sulphite Railroad Bridge, Merrimack County, New Hampshire.

roads and bridges, which grew rapidly after the American Revolutionary War, coupled with access to abundant forests, spurred the development of timber bridge design. These advancements were evolutionary in nature, each responding to a particular aspect of the challenge confronting bridge builders: to create economical and efficient structures that could span long distances, that were easy to erect and maintain, and that were strong enough to carry heavy moving loads.

Because little was known about the structural action of trusses, early timber truss bridges were framed as, or combined with, a more familiar and proven structural form—the arch. The ancient structural form of the arch utilizes the principle of compression to span long distances and is the only way to construct long spans of masonry. Most major bridges in Europe were masonry arches and British books available in eighteenth-century America discussed bridge building solely in terms of arch construction.[32] In America, with few exceptions, masonry bridges were too expensive and labor-intensive to build, so the arch form was adapted to less expensive timber construction.

Burr Truss. Bridge builder Theodore Burr (1771-1822) experimented with a number of innovative arch-truss configurations before settling on a multiple kingpost truss combined with segmented arches. A major advantage of this design was that it allowed for a level deck, an important feature for multiple-span bridges, and later, for railroad bridges. Burr patented his design in 1806 and 1817.[33] The Burr truss was popular in the mid-nineteenth century for both railroad and roadway bridges. Of the thousands of Burr truss covered bridges that once existed, about 185 historic (pre-1955) examples survive in the United States (primarily in the Midwest and eastern United States), with dates ranging from 1825 to 1922. A standard Burr truss uses segmented arches (rather than laminated arches)[34] and multiple kingpost trusses that usually have an even number of panels of about nine feet each. Some of the finest examples are located in Pennsylvania and Indiana.[35]



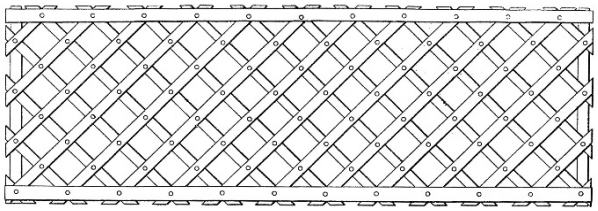
BURR TRUSS. Theodore Burr, United States Letters Patent No. 2769X, 3 April 1817.

By 1820, the potential span length of timber bridges had been extended to over 350 feet, and the practicality of the truss principle had been tested, even though its theory was still not fully understood. Combination arch-truss bridges were commonly built at major crossings, but the use of hewn timbers, mortise and tenon joints and massive piers and abutments required to resist the thrust of the arch made construction of such bridges expensive and labor intensive. Builders began looking for ways to simplify construction so that substantial bridges could be built affordably in many more locations.

Town Lattice Truss. In 1820, architect Ithiel Town (1784-1844) patented a bridge truss entirely free from arch action.[36] His design consisted of a rectangular frame connected by a series of overlapping diagonal planks fastened together with wood pins to form a lattice web. In 1821, Town published a pamphlet describing this design as “the most simple, permanent, and economical, both in erecting and repairing,” and emphasizing the necessity of a less expensive method of bridge construction as a solution to “the great and increasing demand for wooden bridges in all parts of this extensive country.”[37] The Town lattice truss rapidly became popular

[32] Kniffen, 118.
[33] The first patent was lost in the 1836 patent office fire, but the second was recovered.
[34] A segmented arch is constructed of timbers butted end to end, while a laminated arch is constructed of several thicknesses of plank stacked on top of each other, bent to shape and bolted together.
[35] Joseph D. Conwill, “Burr Truss Bridge Framing,” *Timber Framing*, No. 78 (December 2005), 4.
[36] Ithiel Town, United States Letters Patent No. 3169X, 28 January 1820.
[37] Ithiel Town, A Description of Ithiel Town’s Improvement in the Construction of Wood and Iron Bridges: Intended as a

because it utilized sawn planks instead of heavy hewn timbers, and did not require massive abutments to resist the thrust of an arch.



TOWN LATTICE TRUSS. Ithiel Town, United States Letters Patent No. 3169X, 28 January 1820.

The Town lattice system continued to be used for bridges until well into the first half of the twentieth century, and hundreds, if not thousands, of the type were built.[38] There are about 110 extant historic (pre-1955) Town lattice covered bridges in the United States (primarily in the Northeast and South), with dates ranging from 1829 to 1935.[39] Some of the finest examples are located in Vermont. In the 1820s and 1830s, Americans began to apply science to the technical problems associated with the nation's industrial, geographic, and economic expansion.[40] Institutions and engineering schools emerged to provide specialized training in science and technology.[41] Curriculums included courses in applied math and science as well as training in the construction of roads, canals and bridges. Publication of technical journals and textbooks also served to diffuse mathematical and scientific principles. The advent of the railroad spurred this scientific movement and the growth of civil engineering as a profession. Training in math and science allowed bridge designers to examine how members of a bridge functioned under loading, and attempt to design them accordingly. The focus turned to building bridges that were both economical and structurally efficient. As scientific understanding of truss action increased, the focus turned to building bridges that were not only economical but also structurally efficient.

Long Truss. One of the first bridge builders to apply mathematical theory to the practice of bridge building was Col. Stephen H. Long (1784-1864) of the U.S. Army Corps of Engineers. In 1829, Long built his first timber bridge ("Jackson Bridge") at Baltimore, Maryland. That structure, which carried the Washington-Baltimore Road over the Baltimore & Ohio Railroad, was a 110-foot, 12-panel truss with paired diagonal braces and single counterbraces in each panel. The use of counterbraces, Long explained, would result in "stiffness of structure, and exemption from trembling, springing and oscillations of every kind."[42] In 1830, Colonel Long received a patent for this design, which he claimed would result in "greater simplicity and economy in the construction of bridges, together with greater strength and efficiency than have hitherto been attained."[43] Timber bridges deflect when loaded, and spring back up when unloaded. The Long truss addressed this by introducing the

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General System of Bridge-Building (New Haven, Connecticut: S. Converse, 1821), 3-4.

[38] In Alabama, the Town lattice truss was used into the 1930s.

[39] Town lattice roof trusses were reportedly used in the Second Presbyterian Church (1835), Madison, Indiana, and the First Presbyterian Church (1832) at Fayetteville, North Carolina, as well as the Morman Tabernacle (1864) in Salt Lake City, and the Governor Thomas Bibb House (1836) in Huntsville, Alabama. These diverse and geographically scattered examples suggest a broader study of the Town lattice roof truss would be useful.

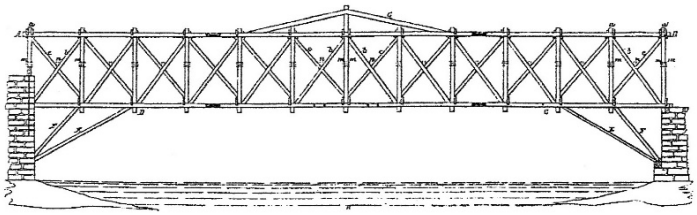
[40] Lawrence P. Grayson, The Making of An Engineer: An Illustrated History of Engineering Education in the United States and Canada (New York: John Wiley & Sons, Inc., 1993), 24.

[41] Established in 1802, West Point Military Academy is the oldest institution in the United States to offer academic instruction in civil engineering. Its curriculum was modeled after the École Polytechnique in France. Civilian engineering schools were established at Norwich, Vermont in 1819 and Rensselaer, New York in 1828.

[42] S.H. Long, *Description of Col. Long's Bridges, Together with a Series of Directions to Bridge Builders* (Concord, New Hampshire: John F. Brown Printers, 1836), 42.

[43] Stephen H. Long, United States Letters Patent No. 5862X, 6 March 1830. In most Long truss bridges, the struts below the bottom chord and framing above the upper chord were eliminated.

concept of "prestressing," using counterbraces, stressed with wedges driven into the connections, to make a more rigid structure.[44]

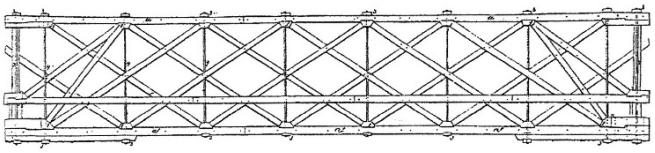


LONG TRUSS. Stephen H. Long, United States Letters Patent No. 5862X, 6 March 1830.

In 1836, Colonel Long published a pamphlet detailing his patent, with tables of dimensions for timber, particularly for the bottom chords, which he considered the most important elements of the structure.[45] Long introduced these scientific principles of engineering to American bridge building, which to the time had been largely dependent on empirical methods.

Some of the first truss railroad bridges in the United States used the Long truss because of its ability to carry heavy loads without excessive deflection. The type advanced understanding of structural behavior and laid the foundation for the development of iron trusses, which dominated bridge building by the end of the nineteenth century. There are only eight historic (pre-1955) examples of the Long truss scattered throughout the eastern United States, with dates ranging from 1840 to 1888. The purest examples have wedges acting on the counterbraces. It is not known how many Long truss covered bridges have this feature, but at least some do not.[46]

Howe Truss. The Howe truss was a highly successful patented design that was the culmination of nearly a half-century of timber bridge evolution in America. In the 1830s, demand increased for standardized bridges that could be rapidly erected to keep pace with the growth of the nation's railroad network. In 1840, Massachusetts millwright William Howe (1803-1852) patented a timber truss with parallel chords connected by diagonal wood compression members and vertical iron tension members.[47] The Howe truss improved on the 1830 Long truss by using adjustable wrought iron rods, in place of wood members, to overcome the inherent difficulty of creating tension connections in wood structures and allow for easier and more efficient pre-stressing of the members.



HOWE TRUSS. William Howe, United States Letters Patent No. 1,711, 3 August 1840.

Railroads favored the Howe truss design because it had standardized framing connections and could be quickly erected and easily adjusted. The American Society of Civil Engineers termed the Howe truss, "the most

[44] Prestressing involves creating stresses in a structure to improve its performance under loading.

[45] S.H. Long, *Description of Col. Long's Bridges, Together With a Series of Directions to Bridge Builders* (Concord, New Hampshire: John F. Brown Printers, 1836). This demonstrated Colonel Long's understanding of the work of French engineer Claude Navier (1785-1836), one of the first engineers to develop a mathematical formula for analyzing the forces in the chords of a truss.

[46] Eldean Bridge (1860), in Miami County, Ohio, and Blair Bridge (1869), in Grafton, New Hampshire, both have wedges on the counterbraces.

[47] William Howe, United States Letters Patent No. 1,711, 3 August 1840. Howe received another patent in 1846 and a reissue in 1850, but the design of most Howe truss bridges was simpler than that shown in the patent drawings.

perfect wooden bridge ever built," adding, "others have been designed of greater theoretical economy; but for simplicity of construction, rapidity of erection, and general utility it stands without rival."[48] Used extensively for railroad bridges during the mid-nineteenth century, the combination wood-iron Howe truss was gradually superseded by iron and later steel structures, but the type remained one of the most important timber truss types throughout the nineteenth century.[49]

The Howe truss saw a revival in Oregon after World War I, when steel shortages, coupled with readily available timber, led to a new era of covered bridge building. The Oregon State Highway Commission offered bridge design services to county engineers, who built covered bridges from the 1920s into the early 1950s. Hundreds, perhaps thousands, of timber Howe truss covered bridges once existed in the United States, about 110 historic (pre-1955) examples survive, primarily in the Midwest and Pacific Northwest. Their construction dates range from 1854 to 1954. The purest examples of the widespread commercial Howe truss have cast iron angle blocks and the standard endpost treatment (two vertical posts with an iron tension rod between them and wood angle blocks on the final braces).[50]

COVERED BRIDGE ARCHITECTURE

Covering a timber bridge was an economic measure, designed to lengthen the life of the structure.[51] Since most species of wood suitable for structural applications deteriorate rapidly when exposed to the weather, bridge builders quickly learned the value of covering the structural components of a bridge with a roof and siding to keep them dry. A wood bridge left uncovered might last fifteen years, but when covered, it can last indefinitely. In 1804 Timothy Palmer, builder of America's first covered bridge stated unequivocally that covering timber bridges was a wise investment, noting that a number of non-housed bridges he erected in the 1790s had since been rebuilt, or extensively repaired, or were decayed and unsafe for travel.[52] By 1810, adding a roof and siding to timber bridges was common practice in America. In some timber-rich regions, covered bridge building continued long after iron bridges became the norm. Covered bridge building saw a revival in Oregon after World War I when steel shortages, coupled with an abundance of relatively cheap, good quality lumber, led to a new era of covered bridges constructed in that state that lasted until 1954.

The earliest covered bridges were magnificent structures, in terms of both engineering and architecture. Financed with private capital, the early turnpike bridges were all custom-built structures, wide enough for two lanes of travel, with highly ornamented exteriors. The Schuylkill Permanent Bridge was probably one of the most extravagant, but other grand covered bridges once existed at major river crossings along the east coast.[53] By 1820, covered bridges were much more common and less ornate. Covered bridges built by towns

[48] "Bridge Superstructure," Transactions of the American Society of Civil Engineers, 1878, 340.

[49] In 1844, railroad engineer Thomas Pratt (1812-1875) and his architect father Caleb Pratt obtained a patent for a bridge truss that reversed the configuration of the Howe truss, putting the shorter web members in compression, which reduced the chances of structural failure through buckling. Few timber Pratt truss bridges were ever built, but the type was successfully adapted to steel and came to be favored for its strength and straightforward design; by the 1890s, it was the standard American truss type for moderate metal railroad and highway spans and remained so well into the twentieth century. There are three historic (pre-1955) timber Pratt truss covered bridges in the United States, but all are in somewhat altered condition: Felton Bridge (1892), Santa Cruz County, California; Honey Run Bridge (1886), Santa Cruz County, California; and Sulphite Railroad Bridge (1896), Merrimack County, New Hampshire.

[50] Pine Bluff Bridge (1886) in Putnam County, Indiana is an outstanding example of a standard late-nineteenth century Howe truss.

[51] Covering a wood bridge is the most reliable way to protect it from decay, but in some instances, builders did away with the housing in favor of treating the timbers with chemical preservatives or protecting the top chords with sheet metal. Structurally, non-housed timber truss bridges share a common history with covered bridges, but very few have been preserved. There are widely scattered examples of non-housed timber truss bridges across the United States and significant numbers are still in use in Canada.

[52] Peters, 48-49.

[53] The Schuylkill Permanent Bridge is discussed in the previous section, "America's First Covered Bridge."

and counties were often quite plain in appearance. Nevertheless, architectural variations occurred, often on a regional level, reflecting the use of local materials and building traditions.

For example, covered bridges in southeastern Pennsylvania often had long stone masonry approaches and stepped gables; most of the covered bridges in Madison County, Iowa had flat roofs and arched portals; covered bridges erected by the Kennedy family of Rush County, Indiana, bore ornamental scrollwork and cornice brackets; and covered bridges built during the 1920s and 30s in Blount County, Alabama were covered with corrugated metal roofing and siding. In Oregon, where covered bridges were built according to state-issued plans into the 1950s, each county developed its own distinctive bridge housing style.

Because the housing was considered expendable and expected to be periodically replaced, most covered bridges were left unpainted until the mid-twentieth century. Those that were painted might be red or white, but other colors were also used. By the 1950s, Americans decided, for reasons yet unknown, that covered bridges should be red. Within two decades, one-third of America's covered bridges were painted red. The term "covered bridge red" even slipped into modern advertising to market such items as paint, yarn, and wine. A popular Christmas card of the former Bedell Bridge (1866-1979) which spanned the Connecticut River at Newbury, New Hampshire, was even tinted red, although the bridge itself had never been painted.[54]

PRINCIPAL DESIGNERS AND BUILDERS

Joseph A. Britton (1838-1929) of Parke County, Indiana, was a prolific covered bridge builder. As a young man with only a few months of formal schooling, Joseph Britton apprenticed with his father, Charlton Britton (b.1800), who was a skilled carpenter. After serving in the Civil War, Britton practiced law in Lawrence, Kansas. In 1879, he returned to Parke County, Indiana and took up carpentry. His first bridge was the Narrows Bridge (1882) across Sugar Creek, a structure that is still standing.

Together with his sons, he went on to build at least 30 covered bridges in Indiana between 1882 and 1920. Britton favored the Burr truss, but occasionally used other types of trusses for his bridges.[55] Sixteen of Joseph Britton's bridges are still standing in Indiana, including the Pine Bluff Bridge (1886) in Putnam County, which is an outstanding example of a timber Howe truss bridge and a fine example of Joseph Britton's work.[56]

Theodore Burr (1771-1822) is a major figure in the history of covered bridge building and the inventor of the Burr truss. He was born in Connecticut and learned construction at an early age from his father, who was a millwright. In 1800, Burr built his first bridge, a timber stringer span, near his sawmill at Oxford, New York and subsequently experimented with a wide variety of timber arch designs for bridges that spanned the Hudson, Mohawk, Delaware and Susquehanna rivers. His masterpiece was the short-lived, 367-foot McCall's Ferry Bridge (1815), the longest timber arch ever built.[57] By 1818, Burr had built 45 bridges "with arches from 60 to 367 feet span."[58] In 1806 and 1817, he patented the truss design that bears his name. The Burr truss was an innovative new design: a multiple kingpost truss combined with segmented arches. A major advantage of this design was that it allowed for a level deck, an important feature for multiple-span bridges, and later, for railroad bridges. In 1822, Burr died under mysterious circumstances while supervising construction of a bridge at Middletown, Pennsylvania. The Union Bridge (1804) spanning the Hudson River at Waterford, New York was the last survivor of the bridges Burr built himself; it was destroyed by fire on July 10, 1909.

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[54] Joseph D. Conwill, "The Red Covered Bridge: Fiction Affects Fact," unpublished typescript, 26 July 2004.

[55] Phillips Bridge (1909) in Parke County, Indiana is a multiple kingpost truss and Pine Bluff Bridge (1886) in Putnam County, Indiana is a Howe truss.

[56] See HAER No. IN-103, Pine Bluff Bridge, Putnam County, Indiana.

[57] Theodore Burr, "McCalls Ferry Bridge," *Niles' Weekly Register*, 18 November 1815, 200. The McCall's Ferry Bridge was destroyed by ice in 1818.

[58] Henry J. Galpin, *Annals of Oxford, New York*, (Oxford, New York: by author, 1906).

Lemuel Chenoweth (1811-1877) of Beverly, West Virginia, was a well-known regional bridge builder. The oldest of eight children, Chenoweth received a meager education in the local country schools, but possessed an aptitude for math and mechanics. As a young man, he learned carpentry and became a skilled craftsman, designing and building furniture, wagons, cabinetry and houses. Chenoweth was a proponent of regional development and held a number of public offices, including a year (1870) in the state legislature. In 1846, he built his first bridge for the Staunton-Parkersburg Turnpike in his hometown, and subsequently was busy with bridge contracts for well over a decade. Several of Chenoweth's sons worked with him building bridges. Of the 12 covered bridges attributed to Chenoweth, two are still standing: Barrackville Bridge (1853) in Marion County, West Virginia and Philippi Bridge (1854) in Barbour County, West Virginia.[59] Both bridges have been extensively altered.

Joseph John ["J.J."] Daniels (1826-1916) was Indiana's most prolific covered bridge builder. His father, Stephen Daniels (1797-1853), was a bridge builder and an agent of Col. Stephen H. Long. Working alongside his father on railroad bridges across southern Ohio, J.J. Daniels learned the trade of bridge building. In 1855, he became superintendent of the Evansville & Crawfordsville Railroad, a position he held for several years. In 1861, he moved to Parke County, Indiana, where he began a prolific 50-year bridge building career. Daniels reportedly erected as many as 50 covered bridges in Indiana. Of these, 19 were railroad bridges and 31 were highway bridges. Seventeen of J.J. Daniels' bridges are still standing and seven are still in use, including the West Union Bridge (1876) in Parke County, which is an outstanding example of his work.[60]

William Henry Gorrill (1841-1874) was a California bridge builder who introduced the Smith truss on the West Coast.[61] Originally from Toledo, Ohio, he was a lawyer before he became involved in bridge building. In the fall of 1869, Gorrill traveled to California, where he hoped the climate might slow the progression of his tuberculosis. In order to support himself while there, he became an agent for the Toledo-based Smith Bridge Company, for which he had already done some legal work. He established the Pacific Bridge Company at Vallejo, advertising its specialty as "all kinds of wooden bridges on Smith's Patent Truss Plan."[62] The successful completion of a 400-foot bridge at Oroville, California in 1871 was followed by a steady flow of work and the company soon expanded its operations with a permanent mill yard in San Francisco. Following William Gorrill's death in 1874, his brothers, Charles H. (1845-1886) and Richard W. (b.1848) took over leadership of Pacific Bridge Company, which remained a major contracting firm into the 1960s. Their projects included Hoover Dam, piers for the Golden Gate and Oakland Bay bridges, and major spans across the Willamette and Columbia rivers. The Powder Works Bridge (1872) in Santa Cruz County, California is the only extant covered bridge built by the Pacific Bridge Company and the only surviving Smith truss bridge on the West Coast.[63]

Herman Haupt (1817-1905) of Philadelphia, Pennsylvania, was a military officer who figured prominently in the development of American railroads and a pioneer in the field of structural analysis. After earning an engineering degree from the U.S. Military Academy at West Point in 1835, Haupt began his career surveying railroad lines in Pennsylvania. Within a short time, he was a highly sought-after engineering consultant. In 1839, Haupt patented an "improved lattice" truss that theoretically had a greater load-carrying capacity than a standard Town lattice truss.[64] The type was almost immediately eclipsed by the 1840 Howe truss and never came into the mainstream of covered bridge building, but one example of the type survives in North Carolina.[65] Herman Haupt's many accomplishments included serving as an engineer for the Pennsylvania Railroad and

[59] See HAER No. WV-8, Barrackville Bridge, Marion County, West Virginia.
[60] See HAER No. IN-105, West Union Bridge, Parke County, Indiana.
[61] Albert Serle Miller (1821-1909) is perhaps a better known Smith Bridge Company agent. But although Miller also traveled to California in 1869, he began operations later than William Gorrill, who may rightly be regarded as one of the true pioneers of this distinctive bridge type in the West.
[62] "The Smith Patent Truss Bridge," Mining & Scientific Press: An Illustrated Journal of Scientific and Industrial Progress, 13 March 1871, 1.
[63] See HAER No. CA-313, Powder Works Bridge, Santa Cruz County, California.
[64] Herman Haupt, United States Letters Patent No. 1,445, 27 December 1839.
[65] See HAER No. NC-46, Bunker Hill Bridge, Catawba County, North Carolina.

playing an instrumental role in the construction of the Western Railroad's Hoosac Tunnel in Massachusetts. In 1861, General Haupt was appointed Chief of United States Military Railroads. His skill in securing railroad lines and building bridges during the Civil War earned him a prominent place in American history. Haupt's seminal work, *General Theory of Bridge Construction* (1851) became a standard textbook in engineering schools across the country.[66] Haupt's son Lewis (b.1844) also became a well-known civil engineer.

William Howe (1803-1852) of Spencer, Massachusetts, was a millwright and the inventor of the first truss type to incorporate iron for primary structural members. In 1839, Howe built a small railroad bridge across the Quaboag River at Warren, Massachusetts.[67] The structure so impressed railroad engineer George Washington Whistler (1800-1849) that he gave Howe the contract for an enormous bridge to carry the Western Railroad across the Connecticut River at Springfield, Massachusetts. In 1840, Howe received a patent for his truss design, which had wood diagonals in compression and iron verticals in tension.[68] The Howe truss improved on the 1830 Long truss by using adjustable wrought iron rods to overcome the inherent difficulty of creating tension connections in wood structures and allow for easier and more efficient pre-stressing of the members. That same year, Howe moved to Springfield, Massachusetts, where he entered into the bridge building business with his brother-in-law, Amasa Stone, Jr. (1818-1883) of Cleveland (and formerly Massachusetts).[69] Howe continued to sell patent rights to companies throughout the country and received royalties that earned him a sizeable fortune. None of the bridges built by William Howe survive.

Archibald M. Kennedy (1818-1897) of Rushville, Indiana, was the patriarch of a three-generation family of covered bridge builders who, over the course of a half-century, built nearly 60 covered bridges in eastern Indiana. Born in North Carolina in 1818, Archibald Kennedy moved to Indiana with his family when he was seven. He began working as a carpenter in 1841 and turned his attention to building covered bridges in 1870. His sons, Emmett (1848-1938) and Charles (1853-1921) assisted him, and Emmett became a prominent builder in his own right. In 1883, Archibald Kennedy retired from bridge building to pursue state politics, and Emmett carried on the family business until 1918. In later years, Emmett was assisted by his sons Karl and Charles. Nearly all of the Kennedy bridges used the Burr truss system and were recognized for being both extremely well-built and beautiful.[70] There are nine Kennedy bridges still standing in Indiana, including the Forsythe Bridge (1888) in Rush County, which is an outstanding example of Emmett Kennedy's work.[71]

Horace King (1807-1887) was born into slavery but had a long and prolific career as a highly-esteemed covered bridge builder in the South. In 1832, he began building bridges with his master, John Godwin (1799-1859), and within a short time, his skill and work ethic garnered the respect of prominent members of southern society, enabling King to obtain his freedom in 1846. Although he never attended school, King developed expertise in all aspects of bridge building, from designing plans and bidding on contracts to supervising construction. He later expanded his business to include all types of building construction. King's sons Washington (1843-1910), Marshal (1844-1879), John (1846-1926), and George (1850-1899) worked with their father and became excellent builders in their own right. In 1875, Washington King established his own Atlanta-based construction company, which continued into the 1920s under the leadership of his son Ernest (b.1882). While the true extent of the King family's work remains unknown, historians estimate that they built over 100 covered bridges in the South. Wehadke Creek Bridge (1870) in Harris County, Georgia is the only extant

[66] Herman Haupt, *General Theory of Bridge Construction* (Philadelphia: D. Appleton & Company, 1851).

[67] The Quaboag River Bridge was replaced in 1873 with a larger Howe truss covered bridge capable of carrying two tracks; that bridge was subsequently replaced.

[68] William Howe, United States Letters Patent No. 1,711, 3 August 1840. Howe received another patent in 1846 and a reissue in 1850, but the design of most Howe truss bridges was simplified from the patent drawings.

[69] In 1842, William Howe's brother-in-law, Amasa Stone, Jr. (1818-1883), bought the rights to Howe's patent and formed a bridge company with Azariah Boody (1815-1885) at Springfield, Massachusetts. Boody, Stone & Co. continued under various names until the late-nineteenth century.

[70] "Roster of Bridges Built by Kennedys," *Indiana Covered Bridge Topics*, Vol. 2, No. 2 (March 1947), 7-8.

[71] See HAER No. IN-106, Forsythe Bridge, Rush County, Indiana.

covered bridge known to have been built by Horace King & Sons, but it was moved in 1965.[72] Of the four extant covered bridges built by Washington King, one has been moved and two have been altered; the condition of the fourth—Big Clouds Creek Bridge (1905) in Oglethorpe County, Georgia—is unknown.[73]

Stephen H. Long (1784-1864) of Hopkinton, New Hampshire, was a prominent American engineer, military officer, and the inventor of the Long truss. He graduated from Dartmouth College in 1809 and joined the U.S. Army Corps of Engineers in 1814. He led military surveying expeditions in the American West between 1817 and 1823 and subsequently spent several years helping to survey and build the Baltimore & Ohio Railroad. In 1830, Long obtained a patent for a timber truss that is considered one of the first scientifically designed truss types because the forces in the members could be determined mathematically.[74] Long published a pamphlet on bridge building in 1836, in which he noted having 26 agents in 11 states and listed 14 bridges that had been constructed according to the patent specifications.[75] In addition to his army duties, Long served as a consultant to various railroads until 1856, when he was put in charge of navigation improvements on the Mississippi River. In 1861, Long was called to Washington, DC to serve as commander of the U.S. Army Corps of Engineers, a position he held until his retirement in 1863. There are eight extant Long truss covered bridges in the United States, though none by the designer himself.

Elias McMellen (1839-1916) of Lancaster, Pennsylvania, was a prolific regional bridge builder. At the age of 14, he began his career working as a carpenter's apprentice and built his first bridge at the age of 21. In 1861, he enlisted with the Union Army, where he rose to the rank of Captain. After the war, he returned to bridge-building in Lancaster County. McMellen is the builder of record for at least 36 bridges, at least 25 of which were covered bridges. Twelve of these bridges survive in Lancaster County. Pine Grove Bridge (1884) on Octoraro Creek is one of the finest examples of McMellen's work, but its integrity was severely compromised during a recent rehabilitation.[76]

Peter Paddleford (1785-1859) of Littleton, New Hampshire, was one of New England's most significant nineteenth-century covered bridge builders. He built several major covered bridges, including two across the Connecticut River between Vermont and New Hampshire, as well as numerous lesser-known spans in the upper reaches of Vermont and New Hampshire. Initially, Paddleford used the Long truss for his bridges, but as early as 1834 he had developed his own design, using a multiple kingpost truss with long counterbraces extended over more than one panel, which helped distribute loads and increased the truss's rigidity. Although never patented, the Paddleford truss dominated covered bridge construction throughout northern New England for over half a century. This was due, in part, to the work of Peter's son, Philip H. Paddleford (1815-1876), who went into partnership with his father in 1835 and continued building bridges throughout his life. There are 20 extant historic (pre-1955) Paddleford truss covered bridges in New England, although none built by the designer himself. Sunday River Bridge (1872) in Oxford County, Maine is a very fine example of this type.[77]

Timothy Palmer (1751-1821) was a housewright who became one of America's pioneer bridge builders. Born in Rowley, Massachusetts, he apprenticed with architect Moody Spofford (1744-1828), who is best known for his New England churches. In 1792, Palmer took up bridge building, erecting America's first long-span truss bridge across the Merrimac River at Newburyport, Massachusetts.

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[72] Red Oak Creek Bridge (c.1840s) is often attributed to Horace King, but no primary evidence has been found to confirm this claim. See HAER No. GA-138, Red Oak Creek Bridge, Meriwether County, Georgia.

[73] See HAER No. GA-140, Watson Mill Bridge, Madison County-Oglethorpe County, Georgia.

[74] S.H. Long, United States Letters Patent No. 5862X, 6 March 1830.

[75] S.H. Long, *Description of Col. Long's Bridges, Together With a Series of Directions to Bridge Builders* (Concord, New Hampshire: John F. Brown Printers, 1836). Long's agents included his brother, Dr. Moses Long (1786-1858); his nephew, Horace Childs (1807-1900); and Stephen Daniels (1797-1853), father of Indiana bridge builder J.J. Daniels.

[76] See HAER No. PA-586, Pine Grove Bridge, Chester County-Lancaster County, Pennsylvania. Kaufmann's Distillery Bridge (1874) in Lancaster County, Pennsylvania appears to be another fine example of Elias McMellen's work and may be worthy of further study.

[77] See HAER No. ME-69, Sunday River Bridge, Oxford County, Maine.

Palmer patented his truss design in 1797 and was much in demand as a bridge builder, erecting long timber truss spans across the Merrimac, Kennebec, Connecticut, Piscataqua, Schuylkill, Potomac, and Delaware rivers.[78] Palmer's largest and most noted work, the Schuylkill Permanent Bridge at Philadelphia, was erected in 1804. Shortly after its completion, a roof and siding were added to keep the structure from rotting, giving it the distinction of being America's first covered bridge. Though none of his bridges survive, Timothy Palmer secured his legacy as the preeminent bridge builder of his generation and as the father of American covered bridge building.[79]

Nichols M. Powers (1817-1897) of Clarendon, Vermont, was one of New England's premier covered bridge builders. He apprenticed under bridge builder Abraham Owen (b.1790) of Pittsford, and built his first covered bridge at Pittsford Mills when he was only 20 years old. Powers was active in bridge building between 1837 and 1880. He built many bridges in Vermont and, at the height of his career, had several significant contracts outside New England, including a prominent railroad bridge (1866) across the Susquehanna River at Havre de Grace, Maryland. The Town lattice was his truss of choice, but Powers also experimented with other designs. In addition to building bridges, Powers worked a large farm and ran a cheese factory. Powers' son Charles (1850-1880) worked with his father on the Susquehanna railroad bridge and reportedly had other bridge building contracts in Maine. Of the estimated 20 covered bridges attributed to Nichols Powers, four are still standing in the Northeast. Brown Bridge (1880) in Rutland County, Vermont is an outstanding example of his work.[80]

Robert W. Smith (1833-1898) of Tippecanoe (now Tip City), Ohio, was the inventor of the Smith truss. Smith was home schooled until he was 15, only attending public school for six weeks to study geometry. He learned carpentry from his father and older brother, who were barn builders. Early in his career, Smith ran a woodworking shop and lumberyard, but eventually turned his attention to bridges. In 1867, Smith patented a bridge truss design that, for a decade, made wood bridges competitive with iron bridges, thus demonstrating their commercial viability. In 1869, he established the Smith Bridge Company at Toledo. Bridges were prefabricated to order, shipped to the site, and erected under the supervision of a company agent. The company built hundreds of covered bridges during the 1870s and successfully made the transition to the manufacture of iron bridges. In 1890, the Smith Bridge Company ceased operations and the plant was sold to the Toledo Bridge Company. Twenty examples of the Smith truss survive in the United States, primarily in Ohio and Indiana.

Jonathan Parker ["J.P."] Snow (1848-1933) was born at Concord, New Hampshire and received an engineering degree from the Thayer School of Civil Engineering in 1875. He served as bridge engineer for the Boston & Maine Railroad from 1888 to 1909 and as chief engineer from 1909 to 1911, and during this time he became a staunch advocate of timber bridges. On most railroads, metal truss bridges replaced timber truss bridges in the late-nineteenth century, but the Boston & Maine Railroad continued to maintain and build timber bridges into the early-twentieth century. In 1895, nearly 70 percent of the bridges on Boston & Maine lines were wood. Although they are no longer in service, five covered railroad bridges built during Snow's tenure survive in New England.[81]

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[78] Timothy Palmer built at least ten major bridges: Essex Merrimac River Bridge (1792), Newburyport, Massachusetts; Andover Bridge (1793), Lawrence, Massachusetts; Piscataqua Bridge (1794), Newington, New Hampshire; Haverhill Bridge (1794), Haverhill, Massachusetts; Rocks Bridge (1795), West Newbury, Massachusetts; Little Falls Bridge (1796), Georgetown, Maryland; Cornish Bridge (1796), Cornish, New Hampshire; Kennebec River Bridge (1799), Augusta, Maine; Schuylkill Permanent Bridge (1805), Philadelphia, Pennsylvania; and Easton Bridge (1805), Easton, Pennsylvania. None of these bridges survive.

[79] Palmer's last surviving bridge, the Easton Bridge (1805) at Easton, Pennsylvania, was replaced in 1895.

[80] See HAER No. VT-28, Brown Bridge, Rutland County, Vermont. Powers' engineering masterpiece, Blenheim Bridge (1855) in Schoharie County, New York, was destroyed by flooding during Hurricane Irene in 2011. See HAER No. NY-331, Blenheim Bridge, Schoharie County, New York.

[81] Wright's Railroad Bridge (1906), Sullivan County, New Hampshire; Pier Railroad Bridge (1907); Sullivan County,

Arthur Clayton ["A.C."] Striker (1885-1962) was born in Ontario, Canada and moved to Eugene, Oregon with his family when he was six. He began his bridge-building career as a teenager, when he assisted his father, Aaron Noble Striker (1862-1913), in the construction of Hendricks Bridge across the McKenzie River at Springfield. A.C. Striker joined the Lane County Engineering Department in the early 1920s and in 1928 was promoted to bridge superintendent, a position he held until 1950. Lane County was the first Oregon county to return to building covered bridges in the twentieth century, a practice they continued into the 1940s. Twelve covered bridges survive from A.C. Striker's tenure with the Lane County Engineering Department.[82] Some of these bridges feature one-piece chords of impressive dimensions.[83]

Ithiel Town (1784-1844) of New Haven, Connecticut, was an influential American architect and the inventor of the Town lattice truss. As a young man, he studied architecture under Asher Benjamin (1773-1845). From 1829 to 1835, Town was a partner of Alexander Jackson Davis (1803-1892), a major proponent of the Greek Revival style of architecture. They designed churches, state capitols and other prominent structures on the eastern seaboard. Town also made a significant contribution to the field of engineering when he began building bridges. In 1818 he built North Carolina's first covered bridge across the Yadkin River near Salisbury.[84] In 1820 and 1835, he patented a bridge truss entirely free from arch action. The Town lattice truss consisted of a rectangular frame connected by a series of overlapping diagonal planks fastened together with wood pins to form a lattice web. The Town lattice truss rapidly became popular because the straightforward design could be erected quickly, it utilized sawn planks instead of heavy hewn timbers, and it did not require massive abutments to resist the thrust of an arch. Town aggressively promoted his design and received royalties of $1 per running foot of bridge. As far as we know, Ithiel Town built only a few bridges himself and none of them survive.

Lewis Wernwag (1769-1843) was a noted millwright and bridge builder who emigrated from Germany to America in 1786. He began his career building machinery and in 1810 he turned his attention to the construction of mills and bridges. In 1812, Wernwag erected his most famous bridge, the Lancaster-Schuylkill Bridge, across the Schuylkill River at Philadelphia. Commonly known as "The Colossus," the 340-foot trussed arch was the longest clear span timber bridge in the world at the time and the second longest timber span ever built.[85] During his lifetime, Wernwag erected over 30 covered bridges in the Mid-Atlantic states and the Midwest, including America's first timber railroad bridge (1830) across the Monocacy River in Maryland, a covered bridge on the National Road (1830) at Cambridge, Ohio and the Baltimore & Ohio Railroad Bridge (1836) at Harper's Ferry, West Virginia. None of Lewis Wernwag's bridges survive.

THE POST CIVIL WAR ERA

Soon after the timber truss reached the apex of its development, it was eclipsed by comparable spans of iron. Iron's tensile strength, coupled with its resistance to fire, rot and insects, made it a superior bridge-building material, particularly for railroads seeking rigid bridges that were easy to erect and maintain and capable of carrying increasingly heavy loads.

In 1836-39, Capt. Richard Delafield (1798-1873) of the U.S. Army Corps of Engineers designed and built America's first iron bridge across Dunlap's Creek on the National Road at Brownsville, Pennsylvania.[86] The innovative structure was an 80-foot cast iron arch consisting of five tubular arch rings supporting the roadway. Other engineers tinkered with ideas for iron truss bridges in the 1840s, but enthusiasm for the new material

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New Hampshire; Sulphite Railroad Bridge (1896), Merrimack County, New Hampshire; Contoocook Railroad Bridge (1889), Merrimack County, New Hampshire; and Fisher Railroad Bridge (1908), Lamoille County, Vermont.

[82] See HAER No. OR-119, Pengra Bridge, Lane County, Oregon.

[83] Pengra Bridge (1938) has bottom chords measuring 16″x18″x126′.

[84] The Yadkin River Bridge was replaced sometime after the Civil War.

[85] Lee H. Nelson, *The Colossus of 1812: An American Engineering Superlative* (New York: American Society of Civil Engineers, 1990). The Colossus was destroyed by fire on September 1, 1838.

[86] See HAER No. PA-72, Dunlap's Creek Bridge, Fayette County, Pennsylvania. This structure is still in service.

was tempered by the periodic failure of iron bridges, which led to lingering suspicion of iron in the public mind. Some designers merely substituted iron parts directly for wood, but ignoring the differences in the structural properties of the two materials figured prominently in the 1876 collapse of the Ashtabula, Ohio iron bridge that killed 83 people.[87]

As is often the case when a new building material is introduced, there are successes and failures—radical advancements and technological dead ends. Ultimately, the advantages that iron construction afforded (resistance to fire and rot, greater service life, standardization and centralized manufacture) combined with the disadvantages of timber construction (susceptibility to fire and rot and the need for periodic maintenance), would lead many public officials to view covered bridges as obsolete.

> As to wooden bridges, they are out of date and unsightly, indicating that the communities in which they are located are not abreast of the times. They are liable to be destroyed by fire. They offer such resistance to the wind as to cause them to be racked or blown down by storms or cyclones. They need re-roofing. They are difficult to sled or sleigh through in time of snows. They are repositories for filth, making it disagreeable and injurious to health. They are dark and forbidding and the lurking place for tramps and thieves, saying nothing of the warlocks... As to steel bridges, they are everlasting; can't burn or blow down; are strong and handsome and are free from all the objections of wooden bridges.
>
> - *Eaton Register*, [Eaton, Ohio], 6 February 1896.

In this transitional period, covered wood bridges were still economical, except for very long spans, and there were still opportunities for innovative timber bridge builders to remain competitive, especially in regions where timber was readily available.[88] The surest route to reducing the cost of any construction is to minimize the quantity of materials that goes into it and many timber bridges were overbuilt for the loads they carried. By employing the methods of mathematical stress analysis described by engineer Squire Whipple (1804-1888) in his 1847 *An Essay on Bridge Building*, builders could proportion structural members in the most efficient manner possible, and in doing so, cut costs.[89] From the 1860s onwards, several inventors addressed this challenge and used the new science to build timber bridges more inexpensively so they could compete with iron bridge manufacturers.

Smith Truss. Contractor Robert W. Smith (1833-1898) of Ohio was one of the most successful of the post-Civil War inventors. In 1867, he patented a bridge truss with parallel chords connected by a series of diagonals and counter diagonals.[90] Smith subsequently made several minor modifications to his design, but all Smith trusses followed the same general pattern.[91] The Smith truss was light, strong and efficient and, for a short time, it allowed wood bridges to successfully compete with iron bridges. In 1869, Robert Smith established the Smith Bridge Company at Toledo, Ohio. During the 1870s, hundreds of Smith trusses were built across the country. There are 20 historic (pre-1955) Smith truss covered bridges in the United States (primarily the Midwest), with dates ranging from 1869 to 1881.

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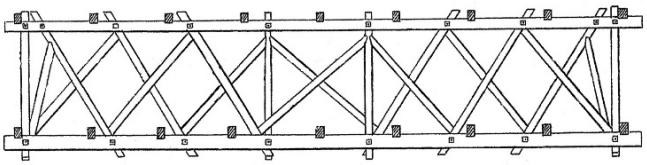
[87] David A. Simmons, "Fall From Grace: Amasa Stone and the Ashtabula Bridge Collapse," *Timeline* [Ohio Historical Society], Vol. 6, No. 3 (June-July 1989), 34.

[88] Some areas of the Midwest still had a reasonable supply of local timber, while others imported it from timber-rich regions of the country. In some places, like Pennsylvania or the Midwest, a strong local tradition and/or the presence of a prominent bridge builder, kept covered bridge building competitive into the late-nineteenth or early-twentieth century.

[89] Squire Whipple, *An Essay on Bridge Building* (Utica, New York: by author, 1847).

[90] Robert W. Smith, United States Letters Patent No. 66,900, 16 July 1867.

[91] In the 1960s, mechanical engineer Raymond E. Wilson of Swarthmore, Pennsylvania, categorized the Smith truss variations as follows: Type 1 follows the 1867 patent; Type 2 follows the 1869 patent; Type 3 is similar to Type 2, but has extra diagonal braces in the center panel; Type 4 has double diagonals and single counters the full length of the bridge. [Raymond E. Wilson, "The Story of the Smith Truss," *Covered Bridge Topics*, Vol. 25, No. 1 (April 1967), 3-5.]



SMITH TRUSS. Robert W. Smith, United States Letters Patent No. 66,900, 16 July 1867.

Other hopeful inventors followed Smith's lead, and at least two received patents that were geometrically similar to the Smith truss, but with minor variations. In 1870, Isaac H. Wheeler (1815-1875) of Sciotoville, Ohio, patented a modified Smith truss with offset compression members and an intermediate chord along the midline of the truss.[92] One remaining example survives in Kentucky.[93] In 1872, Reuben L. Partridge (1823-1900) of Marysville, Ohio patented another modified Smith truss with metal bearing shoes that were intended to reduce the amount of material required for the chords.[94] Five examples of the Partridge truss survive in Ohio.[95] Neither the Wheeler truss nor the Partridge truss ever entered the mainstream of covered bridge building.

By the 1880s, bridge builders had learned how to best utilize the strengths of iron to their advantage and iron came to dominate the field of bridge design. In the last two decades of the nineteenth century, iron and steel bridges began rapidly replacing timber bridges across the country. Communities debated the costs of construction and maintenance of different types of bridges and many were influenced by what neighboring communities were building—prefabricated metal bridges, which were widely marketed by national bridge manufacturing firms. The cost-effectiveness of iron, and later steel, were partially responsible for the decline of timber-bridge building in the first decades of the twentieth century.

THE TWENTIETH CENTURY

At the dawn of the twentieth century, most Americans considered covered bridges neither particularly useful nor worthy of devotion. With the invention and growing popularity of the automobile in the early 1900s, the public began to demand safer, more efficient roads and, in many cases, replacement of covered bridges with modern spans. Most engineers viewed wood as an outmoded material. During WWI, timber and lumber supplies were included in government-controlled war material and that reduced its competitive advantage with steel that was also restricted. By the 1920s, newly formed state highway departments across the country began bypassing or demolishing covered bridges and replacing them with steel and concrete structures that were wider, more open, and better suited for heavy vehicles traveling at increasingly faster speeds. Floods, fires, wind, neglect, and vandalism also took their toll. By the mid-twentieth century, more than 80 percent of the nation's covered bridges had disappeared from the landscape.[96]

[92] Isaac H. Wheeler, United States Letters Patent No. 107,576, 20 September 1870.

[93] See HAER No. KY-49, Bennett's Mill Bridge, Greenup County, Kentucky. This bridge was substantially rebuilt in 2003 and can no longer be considered an historic structure.

[94] Reuben L. Partridge, United States Letters Patent No. 127,791, 11 June 1872.

[95] See HAER No. OH-125, Pottersburg Bridge, Union County, Ohio.

[96] According to research done by Richard Sanders Allen, there were 2,600 covered bridges still standing in 1948; that number dropped to less than 2,000 by 1957. Richard Sanders Allen, "Uncovering Covered Bridge Lore," *Profitable Hobbies*, October 1948, 27-28; Allen, "America's Covered Bridges," *Consulting Engineer*, April 1957, 92.

All things save this have changed within our day
Beside this quiet road nestled in these joyous hills
You point your modest structure toward the sky
Unsought and all unchanged you give us still
Some fragrance of your peace as we go by.

–Verse painted on Lobdell Park Bridge (1871), Licking County, Ohio.[97]

In the face of the technological and industrial advances of the early-twentieth century, covered bridges within pastoral landscapes generated powerful feelings of nostalgia. Artists and antiquarians alike set out to capture covered bridges on paper and canvas. In 1931, Rosalie Wells's (b.1876) *Covered Bridges in America* was published; this was the first book to look at covered bridges from an historical perspective. Around the same time, industrialist Henry Ford (1863-1947) began searching for an historic covered bridge for Greenfield Village, his outdoor museum in Dearborn, Michigan.[98] When a century-old Pennsylvania span was slated for replacement, one of the builder's descendents acquired the structure and offered it to Mr. Ford. In the winter of 1937, Ackley Bridge (1832) was carefully dismantled and trucked to Michigan, where it was re-erected over a man-made pond.[99]

By the 1940s, visiting and photographing covered bridges was a popular hobby, and enthusiasts formed societies to share information. Historian Richard Sanders Allen (1917-2008) founded the quarterly magazine *Covered Bridge Topics* in 1943, and it is still published today. In 1949, the National Society for the Preservation of Covered Bridges (NSPCB) was organized to identify and promote the preservation of America's surviving covered bridges. Other regional societies soon followed.[100] The Ohio Historic Bridge Association (OHBA) was originally formed in 1960 as the Southern Ohio Covered Bridge Association specifically to preserve the abandoned Salt Creek Bridge (1876) in Muskingum County, Ohio.[101] That bridge is now maintained as an historic landmark and tourist attraction. In recent years, the society has expanded its efforts to include all types of historic bridges.

Covered bridge building saw a revival in Oregon after World War I, when steel shortages, coupled with a readily available lumber supply, led to a new era of timber bridge construction. In 1915, the Oregon State Legislature enacted a law requiring all bridges costing more than $500 to be built under the supervision of the Oregon State Highway Commission. The Commission offered bridge design services to county engineers, who built covered bridges from the 1920s into the early 1950s. Most of these bridges used a simplified Howe truss without counterbraces. The availability of large-dimension virgin timber allowed builders to return to traditional timber framing practices (e.g. mortising the braces directly into the chords, rather than using angle blocks), and some bridges used hand-hewn single-stick chords, rather than built-up plank chords. More than 40 historic (pre-1955) covered bridges remain in Oregon and many still carry traffic. The historic era of American covered bridge building ended in Oregon in 1954, when Benton County erected Irish Bend Bridge, the last covered bridge built for purely economic reasons in the United States.

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[97] Bryan E. Ketcham, *Covered Bridges on the Byways of Ohio* (Cincinnati, Ohio: by author), 104.

[98] "Old Covered Wooden Bridges Now Material for Museums," *The New York Time*, 19 April 1931, 123.

[99] In succeeding decades, several other covered bridges were preserved by being moved to various museum properties: Cambridge Bridge (built 1845; moved 1951), Shelburne Museum, Chittendon County, Vermont; Taft Bridge (built 1870; moved 1952), Old Sturbridge Village, Worcester County, Massachusetts; Cedar Chapel (built 1884; moved 1974), Conner Prairie, DeKalb County, Indiana.

[100] The Southern Ohio Covered Bridge Association (1960); Indiana Covered Bridge Society (1963); Theodore Burr Covered Bridge Society (1963); and New York State Covered Bridge Society (1966) were all formed in the 1960s. These groups, along with a number of other more recent organizations, remain active today.

[101] See HAER No. OH-127, Salt Creek Bridge, Muskingum County, Ohio.

Transformation from Structure to Symbol

In the 1930s and 40s, as appreciation for historic structures began to grow, covered bridges reemerged in the public imagination, becoming the subject of folklore and legend. Covered bridges began to appear regularly in American popular culture as nostalgic, romantic, or mysterious elements. Many examples can be found in mid-twentieth century literature, music, radio, film, television, and cartoons. Advertisers, hoping to associate their products with positive images of an idealized America, used covered bridges to market everything from insurance and thermal underwear to cigarettes and beer.

Even though the term "kissing bridge" predates covered bridges by at least 50 years, they have become synonymous in recent times. Covered bridges often provided the seclusion needed for courting couples to steal a kiss unobserved. As one writer put it, "The toll was a kiss for every plank, and the slower the horse the more pleasant the crossing."[102] Later, the idea of the "kissing bridge" provided atmosphere for songs and stories. In 1953, Chesterfield Cigarettes put an artist's rendering of a covered bridge on its holiday promotional carton and followed it up with a pop song, "Kissing Bridge," sung by the Fontane Sisters and Perry Como. More recently, Robert James Waller's best-selling novel *The Bridges of Madison County*, and subsequent movie adaptation, used covered bridges as a backdrop for a bittersweet story of star-crossed lovers that brought droves of tourists and covered bridge enthusiasts to Madison County, Iowa, where five historic covered bridges still stand.[103] Roseman Bridge (1883), which figured prominently in the story, has since become a popular venue for weddings.[104]

In the 1950s and 60s, many Americans built small-scale covered bridges for themselves and sometimes demanded "replicas" of historic covered bridges on public roads. Curiously, while the housing of historic covered bridges was solely a practical consideration to extend the life of a timber bridge, it became the primary focus of these folk art bridges and "replicas." In many instances, the covering was merely a shed built over a concrete slab or steel stringer bridge, creating the illusion of a covered bridge. While these structures might be utilitarian in nature, they bear little resemblance to historic covered bridges, as the covering serves a decorative, rather than functional, purpose.

As affection for covered bridges blossomed nationwide, public officials realized that these structures could be a real asset for tourism. Some local and state governments created wayside parks around bypassed structures, or moved them to sites where they could be preserved as historic landmarks and tourist attractions. Parke County, Indiana, which is home to 30 covered bridges, organized the nation's first covered bridge festival in 1957. This annual event draws thousands of visitors each year.

In 1959, the State of Maine became the first state to pass legislation in favor of preserving its covered bridges. Other states have since followed suit.[105] By the 1970s, communities across the country were recognizing the historical importance of covered bridges and beginning to take steps to preserve them for future generations. In the last few decades, many covered bridges have become cherished local landmarks and symbols of community pride.[106]

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[102] R.J. McGinnis, ed., *The Good Old Days: An Invitation to Memory* (New York: Harper & Brothers, 1960), 61.

[103] A sixth covered bridge, Cedar Bridge (1883), was intentionally burned on September 3, 2002. Author Robert James Waller offered a $10,000 reward for the arrest of the arsonist. A replica of Cedar Bridge was erected in 2004.

[104] See HAER No. IA-95, Roseman Bridge, Madison County, Iowa.

[105] Joseph C. Ingraham, "Maine to Maintain its Covered Bridges," *The New York Times*, 27 March 1960, 13. In 1961, the Maine Department of Transportation rehabilitated the state's 10 extant covered bridges; seven of these structures survive.

[106] Arson is a major challenge to covered bridge preservation. Since the 1950s, nearly 200 of these structures have been deliberately set on fire. On average, two to five covered bridges are annually lost to arson, perhaps, in part, because of their status as local landmarks.

Modern Covered Bridges

In 1936, disastrous spring floods washed out hundreds of covered bridges in New England, including an 84-year-old span in Hillsborough County, New Hampshire.[107] When the New Hampshire State Highway Department proposed replacing it with a reinforced concrete bridge, local residents petitioned for a new covered bridge and the state complied with their request. To achieve a bridge that met Bureau of Public Roads approval, engineer Henry B. Pratt, Jr. (1910-2001) employed a design that lent itself to the kind of structural analysis that would have been applied to a steel truss. The new bridge was wider and taller than its predecessor and made use of a relatively new technology to join the truss members and transmit loads from one member to another: split-ring connectors.[108] County Bridge was one of the first permanent highway spans in the United States to utilize timber connectors and it received national attention when it was written up in *Engineering News-Record*.[109] Many scholars do not consider this an authentic covered bridge, because it does not use traditional framing techniques, but it is the first known example of a covered timber bridge built for purely nostalgic reasons and it marked the dawn of a new era in covered bridge building in the United States.

Milton S. Graton (1908-1994) of New Hampshire is perhaps the best-known covered bridge builder of recent times. His father, Austin Graton (1870-1964), was a carpenter who specialized in building and moving timber-frame structures, and Milton apprenticed with him before starting his own rigging and contracting business. In 1954, while salvaging timber from a collapsed covered bridge, Graton was impressed with the quality of workmanship in the structure and subsequently sought out jobs involving covered bridges. Milton's son, Arnold M. Graton, began working with his father in 1958. Together, they became specialists in the construction and restoration of covered bridges. Between 1958 and 1994, the Gratons built seven new covered bridges, and repaired many more, using traditional materials and framing methods.[110] Arnold M. Graton and his son, Arnold M. Graton, Jr., still carry on the family business.

F. ASSOCIATED PROPERTY TYPES

Property Type: Covered timber bridges

Description: Timber has been used for bridge construction in America since Colonial times. Masonry bridges were expensive and labor-intensive, so many of the country's early bridges were built of wood. Simple pile-and-beam or trestle structures sufficed until the late-eighteenth century, when the demand for bridges increased and builders began developing ideas for framing longer, more substantial spans using arches and trusses. In 1805, the Schuylkill Permanent Bridge at Philadelphia became America's first covered bridge, when it was covered with a roof and siding to increase its lifespan. A wood bridge left uncovered might last 15 years, but when covered, it can last indefinitely. By 1810, timber bridges were traditionally covered with a roof and siding to protect them from the elements.

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[107] See HAER No. NH-42, County Bridge, Hillsborough County, New Hampshire.

[108] Developed in Germany in the 1920s, timber connectors were introduced in the United States in 1933, when the National Lumber Manufacturing Association began studying their potential to increase the serviceability of wood as a building material. Timber connectors were originally manufactured in the United States by the Timber Engineering Company of Washington, DC; thus, they became known as "TECO" connectors. Today, they are manufactured by Cleveland Steel Specialty Company of Ohio. TECO connectors have been used in the construction of many large timber structures, including industrial facilities, water towers, hangars and bridges.

[109] Waldo G. Bowman, "Bridge Building Down East," *Engineering News-Record*, 22 July 1937, 149. Only a few TECO truss covered bridges were ever built. Two others survive in Franklin County, Massachusetts.

[110] During his career, Milton Graton constructed seven new covered bridges: Turkey Jim Bridge (1958), Grafton County, New Hampshire; Union Street Bridge (1969), Windsor County, Vermont; Henniker Bridge (1972), Merrimack County, New Hampshire; Bump Bridge (1972), Grafton County, New Hampshire; Holz-Brűcke Bridge (1980), Saginaw County, Michigan; Hall Bridge (1982), Windham County, Vermont; and Jack O'Lantern Bridge (1986), Grafton County, New Hampshire.

Covered timber bridges were built in nearly all parts of the country where river crossings were needed and timber was readily available. They were constructed to carry vehicles (horse-drawn wagons, trains, canal boats or automobiles) over waterways, topographical depressions or transportation corridors. The earliest covered bridges were built in or near major urban centers, but as their numbers increased, more were built in rural settings. Covered timber bridges were built in large numbers in most parts of the United States until the late-nineteenth century, when they were gradually superseded by comparable iron truss spans, but they continued to be built into the twentieth century in areas where timber was plentiful.

Nearly all covered bridges in the United States are truss bridges.[111] A truss is an assemblage of members joined together to form a series of interconnected triangles, which carry loads by alternately pushing and pulling the individual members. Some covered bridges (approximately 25 percent of surviving examples in the United States) utilize simple truss types (kingpost, queenpost, or multiple kingpost trusses) that date to the Middle Ages. Most of the remaining examples utilize truss designs developed by American inventors in the nineteenth century. The Burr, Town lattice and Howe trusses were the most widely used designs and approximately 60 percent of extant historic (pre-1955) covered bridges are one of these types. The Paddleford truss and the Smith truss were very significant regional types, with 20 examples of each type surviving in the United States.

Significance: A covered timber bridge in the United States may be eligible for National Historic Landmark designation under Criterion 4, as a well-preserved example of a nationally significant truss type (e.g., patented designs that found widespread use) or an outstanding example of covered bridge engineering that may feature unique or distinctive characteristics of bridge design.

Registration Requirements: There are approximately 690 historic (pre-1955) properties that illustrate some or all of the character defining features of the covered bridge property type. Over 75 percent of these properties are listed in, or have been determined eligible for listing in, the National Register of Historic Places. Two covered bridges have previously received National Historic Landmark designation: Ackley Bridge (1832) in Wayne County, Michigan is part of the “Greenfield Village and Henry Ford Museum” National Historic Landmark designated in 1981, and Blenheim Bridge (1855) in Schoharie County, New York, was individually designated as a National Historic Landmark in 1964.[112]

National Historic Landmarks designated under the *Covered Bridges NHL Context Study* must be acknowledged to be among the nation's most significant covered bridges associated with American civil engineering. The association must have occurred between 1805, when America's first covered bridge was built, and 1954, when the last covered bridge was built in the United States for purely economic reasons. The property must be a bridge structure, more than 20 feet long, erected to carry vehicular traffic over a waterway, depression, or other obstruction.[113] The property must be an outstanding representative example of covered timber bridge construction. The property must be located within the boundaries of the United States or its territories and possessions. Each property must also be evaluated against comparable properties before its eligibility for National Historic Landmark designation can be confirmed.

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[111] There are only six pure arch covered bridges in the United States; the rest are truss bridges.

[112] Of the 2,560-plus designated National Historic Landmarks, there are 11 bridges: Eads Bridge (1874), St. Clair County, Illinois-St. Louis County, Missouri; Covington & Cincinnati Suspension Bridge (1867), Kenton County, Kentucky-Hamilton County, Ohio; Carrollton Viaduct (1829), Baltimore County, Maryland; Bollman Truss Railroad Bridge (1852), Howard County, Maryland; Thomas Viaduct (1835), Baltimore County, Maryland; Casselman Bridge (1813), Garrett County, Maryland; Brooklyn Bridge (1883), New York County - Kings County, New York; Old Blenheim Bridge (1855), Schoharie County, New York; S Bridge (1828), Muskingum County, Ohio; Smithfield Street Bridge (1883), Allegheny County, Pennsylvania; Wheeling Suspension Bridge (1849), Ohio County, West Virginia. In addition, Ackley Bridge (1832) in Wayne County, Michigan is part of the “Greenfield Village and Henry Ford Museum” National Historic Landmark nomination.

[113] This excludes culverts, pedestrian bridges and backyard replicas. According to Federal Highway Administration criteria, a bridge has a span of greater than 20 feet, while a culvert has a span of less than 20 feet. The shortest covered bridges listed in the *World Guide to Covered Bridges* are approximately 30 feet long.

In addition to meeting the above criteria, a covered bridge eligible for National Historic Landmark designation must exhibit an uncommonly high degree of integrity. This means that the property must clearly illustrate the character-defining features of the resource type relative to the period of significance, which begins in 1805 and ends in 1954. Approximately half of the 690 historic (pre-1955) covered bridges in the United States have been significantly altered, with much loss of historic fabric and character. For a covered bridge to be eligible for National Historic Landmark designation, it must possess most of the following aspects of integrity:

Location—Location is the place where the historic property was constructed or where the historic event took place. Covered bridges were once located on transportation corridors in 41 of the 50 states. They survive in 29 states, primarily in the Northeast, Mid-Atlantic, Midwest and Pacific Northwest. More than 100 historic covered bridges (about 15 percent) have been moved from their original locations and, generally they are not eligible for National Historic Landmark consideration. Properties proposed for National Historic Landmark consideration will remain in their original locations, unless the move itself is historically significant.[114]

Setting—Setting is the physical environment of an historic property. Covered bridges were constructed to carry vehicles (horse-drawn wagons, canal boats, trains or automobiles) over waterways or other obstacles. The earliest covered bridges were built in, or near, major urban centers; as transportation networks expanded, many more were built in rural settings. With few exceptions, most survivors are located in the countryside, often on lightly-traveled roads. Although some covered bridges have been bypassed, a remnant of the original transportation corridor should be still visible.

Design—Design is the combination of elements that create the form, plan, space, structure, and style of a property. Every covered bridge is uniquely suited to its site; in particular, the length (span) of the bridge is dictated by the site's topography and the materials, framing and architectural details may be dictated by regional building traditions. The structure's essential load-bearing components (trusses, floor system and upper and lower lateral bracing) must be largely intact; if repaired, the repairs should closely approximate the original (see materials, below). Alterations that may have occurred over time as periodic maintenance (e.g. replacement of roof, siding and deck wearing surface) do not necessarily diminish the integrity of the historic design of an otherwise eligible covered timber bridge. Alterations made during the period of significance *may* be considered part of the bridge's historic fabric (e.g. addition of an auxiliary arch to supplement an existing truss system).

Materials—Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property. By definition, an historic covered bridge's primary structural members (truss, arch, or both) must be made of wood. In the case of the Howe truss, the trusses' tension members would be iron or steel; in some cases (e.g. Burr trusses in Indiana), metal tie rods may have been traditionally used in the upper or lower bracing system. Abutments and piers may be wood, stone, metal, concrete, or a combination of these materials, but they should be largely intact or minimally altered. Materials such as glue-laminated timber, split-ring connectors, metal splice plates and steel beams are *not* traditional materials for building or repairing covered bridges. The housing of a covered bridge is traditionally wood (e.g. planks, shingles, clapboards, or board-and-batten siding), although occasionally other materials were used.[115] Roofing was traditionally wood, metal, or slate, but may have been replaced with modern materials, such as asphalt or rubber membrane and these minor changes would not normally preclude NHL eligibility.

Workmanship—Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory. Most covered bridges were built on-site by local craftsmen, although some (e.g. the Howe and Smith trusses) were at least partially manufactured at a distant plant and shipped to the site. With few exceptions, historic covered bridges incorporate traditional timber framing techniques, such as

[114] Ackley Bridge (1832; moved 1937) in Wayne County, Michigan is an exception as it is part of the Greenfield Village.
[115] Blount County, Alabama covered their bridges with metal siding in the 1930s. See HAER No. AL-201, Swann Bridge, Blount County, Alabama.

mortise-and-tenon joints, scarf joints and treenails (pronounced “trunnels”). In every widely-used truss type, regional variations can be found in member sizes, framing techniques and architectural features.

Feeling—Feeling is a property’s expression of the aesthetic or historic sense of a particular period of time. Covered timber bridges proposed for National Historic Landmark designation must clearly convey the feeling of a timber-frame structure built for use on a nineteenth century or early- to mid-twentieth century transportation corridor.

Association—Association is the direct link between an important historic event or person and a historic property. Covered timber bridges proposed for National Historic Landmark designation must convey a direct relationship to the historic development of a nationally or regionally significant structural type. They may also be associated with national trends related to the development of transportation systems, including turnpikes, roadways, canals or railroads.

G. GEOGRAPHICAL DATA

Approximately 690 historic (pre-1955) covered bridges survive in 29 of the 41 states in which they once existed. Nineteenth-century examples are primarily located in the Northeast and Midwest and a significant twentieth-century population exists in the Pacific Northwest. Historic covered bridges survive in the following states: Alabama, California, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, Washington, West Virginia and Wisconsin.[116] Approximately 80 percent of the extant historic covered bridges are located in six states: Pennsylvania (27 percent), Ohio (17 percent), Indiana (13 percent), Vermont (11 percent), New Hampshire (6 percent), and Oregon (6 percent).

H. SUMMARY OF IDENTIFICATION AND EVALUATION METHODS

The structures highlighted in this context study are considered by experts in the field to be the best representative examples of covered timber bridges in the United States. The properties targeted for National Historic Landmark consideration were drawn from the National Covered Bridges Recording Project (NCBRP), undertaken in 2002-2005 by the Historic American Engineering Record (HAER), a long-range federal program that documents historic engineering sites and structures in the United States.[117] HAER is administered by the Heritage Documentation Programs Division of the National Park Service, United States Department of the Interior. The National Covered Bridges Recording Project was funded by the Federal Highway Administration’s (FHWA) National Historic Covered Bridge Preservation Program (NHCBP), established in 2000 by Section 1224 of the Transportation Equity Act for the 21st Century (TEA21). The NHCBPP provides funding to assist states in their efforts to preserve, rehabilitate, or restore the nation's historic covered bridges.

The initial group of covered bridges studied by HAER in 2002-2003 was chosen by historian Joseph D. Conwill, one of the nation’s leading covered bridge authorities and editor of *Covered Bridge Topics*, the quarterly magazine of the National Society for the Preservation of Covered Bridges (NSPCB). Mr. Conwill was one of the members of an informal advisory group of engineers and covered bridge experts who individually submitted recommendations of covered bridges for HAER to record in 2002.[118] Of the 109 covered bridges suggested in

[116] Areas where covered bridges were not built include the heart of the Rocky Mountain region, the Northern Plains, the Southern Plains, Louisiana and Florida.

[117] The Historic American Buildings Survey (HABS) began recording covered bridges in 1933 and the Historic American Engineering Record (HAER) began recording covered bridges in 1970. Between 1933 and 2001, HABS/HAER recorded 85 covered bridges; approximately 60 percent of those structures are no longer standing. From 2002 to the present, HAER recorded another 75 covered bridges as part of the National Covered Bridges Recording Project; approximately 5 percent of those structures are no longer standing.

[118] The following advisory group members submitted written recommendations for the HAER recording project:

writing by members of the advisory group, 10 structures received the recommendation of the majority; these bridges are marked with an asterisk (*) in the chart on the following page.[119] Ultimately, Mr. Conwill's recommendations were used as the basis for the HAER project, as he has seen every covered bridge in North America (including nearly 200 that no longer exist), and thus, had some basis for comparing each bridge with all the other examples in the United States.[120]

The covered bridges selected for HAER recording were chosen based on three primary criteria: 1) engineering significance; 2) historical significance; and 3) structural integrity. Secondary criteria for selection included significance of the designer or builder, aesthetics of bridge and site, and potential to yield new information. The initial list of 31 properties selected for HAER recording is shown in the following chart.

*	NR	HAER #	BRIDGE	STATE	COUNTY	DATE	TYPE	DESIGNER / BUILDER
	I	AL-201	SWANN	AL	BLOUNT	1933	TOWN	ZELMA TIDWELL
	I	CA-312	HONEY RUN	CA	BUTTE	1886	PRATT	AMERICAN BRIDGE CO.
*	D	CA-314	KNIGHT'S FERRY	CA	STANISLAUS	1864	HOWE	STANISLAUS BRIDGE & FERRY CO.
	E	CA-313	POWDER WORKS	CA	SANTA CRUZ	1872	SMITH	PACIFIC BRIDGE CO.
	I	GA-138	RED OAK CREEK	GA	MERIWETHER	c1840	TOWN	UNKNOWN
	I	IN-104	CATARACT FALLS	IN	OWEN	1876	SMITH	SMITH BRIDGE CO.
	T	IN-105	WEST UNION	IN	PARKE	1876	BURR	J.J. DANIELS
	T	IN-106	FORSYTHE	IN	RUSH	1888	BURR	EMMETT L. KENNEDY
	E	IN-103	PINE BLUFF	IN	PUTNAM	1886	HOWE	JOSEPH A. BRITTON
	I	IA-64	HOLLIWELL	IA	MADISON	1880	TOWN	H.P. JONES / G.K. FOSTER
	I	ME-69	SUNDAY RIVER	ME	OXFORD	1872	PADDLEFORD	HIRAM YORK
*	I	NH-33	BATH-HAVERHILL	NH	GRAFTON	1829	TOWN	UNKNOWN
	I	NH-34	BATH	NH	GRAFTON	1832	MOD. BURR	UNKNOWN
*	I	NH-35	WRIGHT'S	NH	SULLIVAN	1906	TOWN	BOSTON & MAINE RAILROAD
	I	NY-330	HYDE HALL	NY	OTSEGO	1825	BURR	CYRENUS CLARK
*	NHL	NY-331	BLENHEIM	NY	SCHOHARIE	1855	LONG / ARCH	NICHOLS M. POWERS
	I	NY-329	BEAVERKILL	NY	SULLIVAN	1865	TOWN	JOHN DAVIDSON
*	I	NC-46	BUNKER HILL	NC	CATAWBA	1894	HAUPT	ANDREW L. RAMSOUR
	I	OH-123	CRUM	OH	MONROE	1867	M. KINGPOST	FOUTS & TOWNSEND
	I	OH-122	ELDEAN	OH	MIAMI	1860	LONG	JAMES & WILLIAM HAMILTON
	T	OR-119	PENGRA	OR	LANE	1938	HOWE	A.C. STRIKER
	T	OR-120	SHORT	OR	LINN	1945	HOWE	LINN COUNTY ENG. DEPT.
	I	PA-587	DREIBELBIS	PA	BERKS	1869	BURR	SIMON DREIBELBIS
	I	PA-588	UHLERSTOWN	PA	BUCKS	1856	TOWN	MAHLON LEAR
	I	PA-586	PINE GROVE	PA	CHESTER-LANCASTER	1884	BURR	ELIAS McMELLEN
	D	TN-41	DOE RIVER	TN	CARTER	1882	HOWE	THOMAS MATSON / E.E. HUNTER
	I	VT-29	FLINT	VT	ORANGE	1874	QUEENPOST	IRA MUDGETT
	I	VT-28	BROWN	VT	RUTLAND	1880	TOWN	NICHOLS M. POWERS
*	I	VT-30	TAFTSVILLE	VT	WINDSOR	1836	M. KINGPOST	SOLOMON EMMONS III
*	I	VA-1	HUMPBACK	VA	ALLEGHENY	1857	M. KINGPOST	KANAWHA TURNPIKE CO.
	I	WV-8	BARRACKVILLE	WV	MARION	1853	BURR	LEMUEL CHENOWETH

Richard Sanders Allen, historian and author; James Barker, J.A. Barker Engineering: Joseph D. Conwill, editor, *Covered Bridge Topics*; Eric N. DeLony, (former) Chief of HAER; David C. Fischetti, DCF Engineering; Chris Leedham, Oregon Department of Transportation; and David W. Wright, President of the National Society for the Preservation of Covered Bridges. David Simmons of the Ohio Historical Society recommended the Eldean Bridge for HAER recording.

[119] Historic American Engineering Record, "HAER Covered Bridges Project Update," Fall 2002, 13 December 2002.

[120] Joseph D. Conwill, "Thirty American Covered Bridges Worthy of Special Recognition," February 2002; and "Research Notes and Annotated Bibliography for HAER Covered Bridge Project 2002," June 2002. Twelve of the selected covered bridges had been previously recorded by HABS/HAER; HAER team members prepared supplemental documentation for these structures.

In the fall of 2002, the initial project list was expanded to include the 19 properties listed below.[121]

*	NR	HAER #	BRIDGE	STATE	COUNTY	DATE	TYPE	DESIGNER / BUILDER
*	I	CA-41	BRIDGEPORT	CA	NEVADA	1862	HOWE	VIRGINIA CITY TURNPIKE CO.
	I	GA-140	WATSON MILL	GA	MADISON	1885	TOWN	WASHINGTON W. KING
	I	IA-95	ROSEMAN	IA	MADISON	1883	TOWN	H.P. JONES / G.K. FOSTER
*	D	IN-108	DUCK CREEK	IN	FRANKLIN	1846	BURR	WHITEWATER CANAL CO.
	T	IN-48	JACKSON	IN	PARKE	1861	BURR	J.J. DANIELS
	I	IN-46	BELL FORD	IN	JACKSON	1868	POST	McNAIRY, CLAFLEN & CO.
	E	NH-39	CLARK'S	NH	GRAFTON	1904	HOWE	BARRE BRANCH RAILROAD
	---	NH-40	BLACKSMITH SHOP	NH	SULLIVAN	1881	M. KINGPOST	JAMES TASKER
	E	NH-41	HONEYMOON	NH	CARROLL	1876	PADDLEFORD	CHARLES A. BROUGHTON
	---	NH-36	SULPHITE	NH	MERRIMACK	1896	PRATT	BOSTON & MAINE RAILROAD
	I	NH-38	CONTOOCOOK	NH	MERRIMACK	1889	TOWN	BOSTON & MAINE RAILROAD
	I	NH-8	CORNISH	NH-VT	SULLIVAN-WINDSOR	1866	TOWN	JAMES TASKER / BELA FLETCHER
	T	OR-24	LARWOOD	OR	LINN	1941	HOWE	LINN COUNTY ENGINEERING DEPT.
	I	PA-624	ACADEMIA	PA	JUNIATA	1902	BURR	JAMES M. GRONINGER
	---	PA-623	BURNT MILL	PA	BUCKS		HOWE	UNKNOWN
	I	VT-31	PULP MILL	VT	ADDISON	1854	M. KINGPOST	UNKNOWN
*	I	VT-32	SHOREHAM RR	VT	ADDISON	c1897	HOWE	RUTLAND RAILROAD
	I	VT-33	MORGAN	VT	LAMOILLE	1887	QUEENPOST	LEWIS ROBINSON / CHARLES LEONARD
	I	WA-133	HARPOLE	WA	WHITMAN	1922	HOWE	GREAT NORTHERN RAILWAY

Over the course of the multi-year project, another 25 covered bridges were recorded for a variety of reasons, including: accommodating the logistical needs of summer recording teams, expanding research on previously-recorded structures, developing regional comparison studies, and documenting endangered structures. Although the original list intentionally excluded minor truss types that were evolutionary dead ends, some of these were later recorded in order to broaden the base of information from which this context study was developed.

The properties targeted for National Historic Landmark consideration in this context study are drawn from the 50 covered bridges listed in the chart on the previous page, with the following exceptions:

- The western span of Bell Ford Bridge in Jackson County, Indiana collapsed in 1999 and the eastern span collapsed in 2006.[122]
- Jackson Bridge in Parke County, Indiana was rebuilt with glue-laminated floor beams in 1977; the bottom chords were replaced with glue-laminated members in 2006.
- Honeymoon Bridge in Carroll County, New Hampshire has been extensively altered and a substantial amount of the original structure has been replaced.
- Clark's Bridge in Grafton County, New Hampshire was moved from its original location in 1964 and, therefore, does not meet National Register criteria.
- Sulphite Bridge in Merrimack County, New Hampshire is in poor condition following a 1980 arson fire, which burned off the siding and damaged the trusses.
- Cornish Bridge in Sullivan County, New Hampshire was extensively modified in 1988 with the addition of glue-laminated chords and floor beams.
- Wright's Railroad Bridge in Sullivan County, New Hampshire has been extensively modified in recent years.
- Pengra Bridge in Lane County, Oregon underwent structural modifications in the mid-1990s.
- Short Bridge in Linn County, Oregon underwent structural modifications in the mid-1990s.
- Uhlerstown Bridge in Bucks County, Pennsylvania underwent rehabilitation in 1985, during which the original floor system was replaced with steel beams.

[121] Joseph D. Conwill, "Supplemental Remarks to My Report on Thirty American Covered Bridges," 2002; "Possible Additions to HAER Covered Bridge Project," 7 August 2002; and "Comments on Proposals for HAER Covered Bridge Project in 2003," Fall 2002. Larwood Bridge was added to the list in consultation with the Oregon Department of Transportation.

[122] The iron components of Bell Ford Bridge were salvaged for potential rebuilding. As of 2010, there were tentative plans to rebuild the bridge in Fort Harrison State Park at Indianapolis.

- Pine Grove Bridge in Lancaster County, Pennsylvania was heavily rebuilt during a recent rehabilitation.
- Barrackville Bridge in Marion County, West Virginia has been heavily rebuilt and much of its historic fabric was lost before the bridge was restored in 1998-99.

The remaining 39 bridges were evaluated against National Historic Landmark criteria, and a list was compiled of 20 covered bridges that have a high level of integrity and are significant as outstanding representative examples of their type, period, and method of construction. Secondary considerations for inclusion in this list were: historical significance, significance of the designer or builder and aesthetics of the bridge and site.[123]

COVERED BRIDGES PREVIOUSLY DESIGNATED AS NATIONAL HISTORIC LANDMARKS

Blenheim Bridge (1855), Schoharie County, New York. Built for the Blenheim Bridge Company in 1855, Blenheim Bridge was a superlative example of nineteenth-century timber bridge engineering and one of the longest single-span covered bridge in the United States.[124] Erected by preeminent New England bridge builder Nichols M. Powers (1817-1897), this double-barrel Long truss covered bridge contained a spectacular central arch, which was an engineering marvel in its day.[125] In 1891, this former toll bridge was made free and turned over to the State of New York. When state officials made plans to demolish the bridge and erect a new span in 1930, the Schoharie County Board of Supervisors voted to retain the covered bridge as an historic relic. In 1932, Blenheim Bridge was bypassed and turned over to Schoharie County. Blenheim Bridge was recorded by HABS in 1936 and by HAER in 2002. It was designated a National Historic Landmark in 1964 and recognized as a National Historic Civil Engineering Landmark by the American Society of Civil Engineers in 1984. On August 28, 2011, Blenheim Bridge was destroyed by flooding from Hurricane Irene.

Ackley Bridge (1832), Wayne County, Michigan. Ackley Bridge is an excellent example of a multiple kingpost truss and a noteworthy early example of covered bridge preservation efforts in the United States. Built in 1832 by Joshua Ackley (b.1805) and Daniel Clouse (b.1812), Ackley Bridge originally spanned Enslow's Branch of Wheeling Creek between Greene County and Washington County in Pennsylvania, where it carried traffic for over a century. In 1937, when the covered bridge was slated for replacement, one of Joshua Ackley's descendents acquired the structure and offered it to industrialist Henry Ford (1863-1947) for his open-air village museum at Dearborn, Michigan. In the winter of 1937, the 80-foot covered bridge was carefully dismantled and transported to Greenfield Village (est. 1929), where it was re-erected over a man-made pond.[126] The structure underwent repairs in 1974, stabilization in 1999, and restoration in 2000. In 1981, Greenfield Village was designated a National Historic Landmark; the nomination includes "all buildings, structures, and objects associated with the Henry Ford Museum and Greenfield Village."[127]

COVERED BRIDGES PROPOSED FOR NATIONAL HISTORIC LANDMARK CONSIDERATION

Humpback Bridge (1857), Alleghany County, Virginia. Humpback Bridge is a superb example of nineteenth-century covered bridge construction. It is a classic multiple kingpost truss, and the older of two surviving examples with radically-cambered chords in the United States, the other being the Geer's Mill Bridge

[123] The properties listed in the chart constitute a valid set from which other examples could be evaluated at a later date. Additional properties meeting the selection criteria could be considered for National Historic Landmark designation based on comparison with the properties contained in this context study.

[124] Blenheim Bridge's original clear span was 210′; the abutments were subsequently modified, making the clear span 199′-1″.

[125] Some of America's earliest covered bridges were double-barrel structures, with side-by-side roadways. Bridges of this type continued to be built on heavily-traveled routes into the 1850s. There are five extant historic (pre-1955) double-barrel covered bridges in the nation: Roberts Bridge (1829), Preble County, Ohio; Ramp Creek Bridge (1838), Brown County, Indiana; Cambridge Village Bridge (1845), Chittendon County, Vermont; Pulp Mill Bridge (1854), Addison County, Vermont; and Philippi Bridge (1854), Barbour County, West Virginia.

[126] Thomas Sutter, "History of Ackley Bridge," *Covered Bridge Topics*, Vol. 33, No. 4 (Fall 1975), 16.

[127] James H. Sheire, National Register of Historic Places Inventory-Nomination Form: "Greenfield Village and the Henry Ford Museum," 1981.

(1874) in Vinton County, Ohio. Presumably, the cambered design was used to give the bridge greater clearance above potential flooding, which was reportedly a regular occurrence on Dunlap Creek. Built in 1857, Humpback Bridge is historically significant as one of the last surviving remnants of the James River & Kanawha Turnpike, the first major overland route through the Alleghany Mountains region. It is the fifth bridge to occupy this site. Humpback Bridge carried traffic until it was bypassed in 1928. In 1953-54, the bridge was preserved in place and the surrounding land developed as a wayside park. Humpback Bridge was listed in the National Register of Historic Places in 1969 and recorded by HAER in 1970 and 2002. This bridge possesses an unusually high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 1.]

Knight's Ferry Bridge (1863), Stanislaus County, California. Located in a picturesque "Old West" setting, Knight's Ferry Bridge is an impressive example of nineteenth-century covered bridge construction and an excellent example of a timber Howe truss, one of the most widely-used timber bridge designs. Built in 1863, Knight's Ferry Bridge was an important crossing on the Sonora Road, one of the principal routes used by miners traveling to and from the southern mines during the California Gold Rush. The bridge carried traffic until 1981, when it was bypassed and closed to vehicles; in 1985, ownership was transferred to the U.S. Army Corps of Engineers. Today, the structure serves as a pedestrian bridge for the Knight's Ferry Recreation Area. The bridge was restored in 1988-1991 and is in an excellent state of preservation. Knight's Ferry Bridge was recorded by HABS in 1934 and by HAER in 2002. It is part of the "Knight's Ferry Historic District," which was listed in the National Register of Historic Places in 1975. This bridge possesses an unusually high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 2.]

Brown Bridge (1880), Rutland County, Vermont. Brown Bridge is an outstanding example of nineteenth-century covered bridge construction, and an exceptionally fine example of the Town lattice truss, one of the most widely used timber bridge designs. Built in 1880, it is the last bridge erected by preeminent New England bridge builder Nichols M. Powers (1817-1897). The bridge's unusual slate roof and the northwest abutment, which makes use of a huge natural boulder, illustrate how nineteenth-century builders used indigenous materials in building covered bridges.[128] Located on a rural road, Brown Bridge never carried heavy traffic and has required only routine maintenance since its construction.[129] It was listed in the National Register of Historic Places in 1974 and recorded by HAER in 2002. This bridge possesses an unusually high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 3.]

Powder Works Bridge (1872), Santa Cruz County, California. Powder Works Bridge is one of the best surviving examples of a Smith truss in the United States, and the only one on the West Coast. Patented by Robert W. Smith (1833-1898) in 1867, the Smith truss was the most successful of several post-Civil War timber truss designs that, for a short time, made wood bridges competitive with iron bridges. This structure was one of the first bridges erected by the Pacific Bridge Company, a nationally significant firm founded by William Henry Gorrill (1841-1874), an agent of the Smith Bridge Company. It is one of the last remnants of the California Powder Works (1861-1914), the first black powder mill on the West Coast. In 1924, the Fresno Masonic Lodge purchased the former powder mill property for a summer cottage colony named "Paradise Park." Powder Works Bridge was rehabilitated in 1967, when a pier was added to increase the structure's load-carrying capacity; it still carries vehicular traffic within Paradise Park. Powder Works Bridge has been determined eligible for listing in the National Register of Historic Places and was recorded by HAER in 2002. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 4.]

Pine Bluff Bridge (1886), Putnam County, Indiana. Pine Bluff Bridge is an exceptionally fine example of a timber Howe truss, one of the most widely-used covered bridge designs. This two-span bridge was erected in 1886 by Joseph A. Britton (1838-1929), one of Indiana's most prolific covered bridge builders. It features cast-

[128] Slate has traditionally been used for roofs of bridges, houses and barns in this part of Vermont. Nearby Poultney, Vermont is a major quarrying center.

[129] Brown Bridge sustained damage during Hurricane Irene in 2011; the extent of that damage is not yet known.

iron angle blocks and the standard endpost treatment that were common in late-nineteenth century Howe truss covered bridges. The bridge was sympathetically rehabilitated in 1986 and continues to carry vehicular traffic. Pine Bluff Bridge was determined eligible for inclusion in the National Register of Historic Places in 1984. It was recorded by HAER in 2002. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 5.]

West Union Bridge (1876), Parke County, Indiana. West Union Bridge is an outstanding example of nineteenth-century covered bridge construction and a very fine example of the Burr truss system, one of the most widely used timber bridge designs. It is also an outstanding example of the work of J.J. Daniels (1826-1916), one of Indiana's most prolific covered bridge builders. This 315-foot, two-span structure replaced an earlier covered bridge that washed out in a flood in 1875. It carried vehicular traffic for nearly a century, until it was bypassed in 1964 and preserved as a local historic landmark. West Union Bridge was listed in the National Register of Historic Places in 1978 as part of the "Parke County Covered Bridges" thematic resource nomination. It was recorded by HAER in 2002. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 6.]

Taftsville Bridge (1836), Windsor County, Vermont. Taftsville Bridge is a superb example of nineteenth-century covered bridge construction and a rare American survivor of the early craftsman tradition of timber truss bridge building, built before covered bridges followed standard designs. Its archaic truss design resembles the heavy timbered bridges of Switzerland, which combined simple trusses to make an effective but highly redundant structure. The builder, Solomon Emmons III (1793-1869), may have been influenced by illustrations of Swiss bridges he had seen in contemporary literature. Since opened to traffic in 1836, Taftsville Bridge has remained in continuous use, and is still a vital link in the local transportation network. It is one of the oldest covered bridges in continuous service in the United States. Its setting in the historic village of Taftsville (a National Register historic district) is of added interest. Taftsville Bridge was listed in the National Register of Historic Places in 1973 and recorded by HAER in 2002. This bridge possessed a high degree of integrity until it was damaged and partially disassembled following Hurricane Irene in 2011. The eligibility of this bridge for NHL status depends upon restoration work planned in 2012. [See photo page 7 for pre-Hurricane view.]

Shoreham Railroad Bridge (1897), Addison County, Vermont. Built in 1897 by the Rutland Railroad Company, Shoreham Railroad Bridge is one of the last surviving examples of a classic Howe truss railroad bridge and one of only six extant fully-covered railroad bridges in the country.[130] The arrangement of tension rods suggests the bridge was strengthened with additional rods sometime after its construction. The bridge carried freight trains until 1951, when the Rutland Railroad abandoned the line and removed the tracks. The Vermont Department of Fish and Game subsequently purchased the bridge and surrounding property and converted a portion of the former railroad right-of-way for recreational use. In 1972, ownership of the bridge was transferred to the Vermont Division for Historic Preservation. In 1983, the structure received a new roof, new siding, and a new eastern abutment. Shoreham Railroad Bridge was listed in the National Register of Historic Places in 1974 and recorded by HAER in 2003. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 8.]

[130] There are six fully-covered, intact railroad bridges in the United States: Contoocook Railroad Bridge (1889), Merrimack County, New Hampshire; Shoreham Railroad Bridge (1897), Addison County, Vermont; Clark's Bridge (1904), Grafton County, New Hampshire; Wright's Railroad Bridge (1906), Sullivan County, New Hampshire; Pier Railroad Bridge (1907), Sullivan County, New Hampshire; and Fisher Railroad Bridge (1908), Lamoille County, Vermont. In addition, there is one boxed pony truss railroad bridge, Boston & Maine Railroad, Berlin Branch Bridge #143.06 (1918), in Coös County, New Hampshire; and one boxed through truss bridge, Harpole Railroad Bridge (1922), in Whitman County, Washington. Sulphite Railroad Bridge (1896) in Merrimack County, New Hampshire is still standing, but all the siding was burned off during an arson attempt in 1980. Boston & Maine Railroad, Berlin Branch Bridge #148.81 (1918), in Coös County, New Hampshire was burned in 2004; the trusses have been salvaged for possible rebuilding.

Duck Creek Aqueduct (1848), Franklin County, Indiana. Duck Creek Aqueduct is a rare surviving example of a covered timber aqueduct.[131] It was one of several similar structures on the Whitewater Canal, which operated between the Whitewater Valley and the Ohio River from 1839 to 1865. After being displaced by the railroad, the canal supplied hydraulic power for the industrial districts at Metamora and Brookville. The aqueduct was strengthened in 1868 and raised 18 inches in 1901. In 1946, the State of Indiana took control of a 14-mile section of the canal and rehabilitated the aqueduct to carry horse-drawn boats for tourists. Duck Creek Aqueduct (also, Whitewater Canal Aqueduct, or Metamora Aqueduct) was recorded by HABS in 1934 and by HAER in 2005. It was listed in the National Register of Historic Places in 1973 as part of the "Whitewater Canal Historic District," and designated a National Historic Civil Engineering Landmark by the American Society of Civil Engineers in 1992. The aqueduct was restored in 2005. It possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 9.]

Forsythe Bridge (1888), Rush County, Indiana. Forsythe Bridge is a visually striking example of nineteenth-century covered bridge construction and an excellent example of the Burr truss, one of the most widely used timber bridge designs. Erected in 1888 by Emmett L. Kennedy (1848-1938), it is one of 58 covered bridges built by members of the Kennedy family of Rushville, Indiana, and one of only eight that survive. The finely-detailed Kennedy bridges are distinguished by their gracefully arched portals featuring ornamental roof brackets and scrolled millwork. Forsythe Bridge was listed in the National Register of Historic Places in 1983 as part of the "A.M. Kennedy House and Covered Bridges of Rush County" thematic resource nomination. It was recorded by HAER in 2002. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 10.]

Bridgeport Bridge (1862), Nevada County, California. Bridgeport Bridge is a remarkable example of nineteenth-century timber bridge engineering. With a clear span of 209′, this Howe truss with auxiliary arches is the longest single-span covered bridge in the United States. It was erected in 1862 for the Virginia City Turnpike, a major route into the Sierra Mountains during the California Gold Rush. Nevada County purchased the bridge in 1901 and it continued to carry traffic until it was bypassed in 1973. The South Yuba River State Park was developed in the late 1980s, at which time the State of California purchased the bridge from Nevada County. Bridgeport Bridge was recorded by HABS in 1934 and by HAER in 2002. It was designated a National Historic Civil Engineering Landmark by the American Society of Civil Engineers in 1970 and was listed in the National Register of Historic Places in 1971. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4; however, the span was recently closed due to structural problems and its future is uncertain. [See photo page 11.]

Eldean Bridge (1860), Miami County, Ohio. Eldean Bridge is the best of eight surviving examples of a Long truss covered bridge in the United States. Patented in 1830 by Col. Stephen H. Long (1784-1864), the Long truss was one of the first truss types where forces in the members could be determined mathematically. This structure is consistent with Long's patent, except the connections of the diagonal members have been simplified, the pre-stressing wedges appear at the bottom of the counterbraces, and there are no counterbraces in the end panels. Located near the site of an 1848 grist mill on an important nineteenth-century overland route through Ohio, Eldean Bridge was built in 1860 by local quarry owners James and William Hamilton. The bridge carried vehicular traffic until 1963, when it was bypassed and preserved in place as a local historic landmark. It was reopened to automobile traffic in 1976 to discourage vandalism. The structure was sensitively rehabilitated in 1980 and 2006. Eldean Bridge was listed in the National Register of Historic Places in 1975 and recorded by HAER in 2002. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 12.]

Roseman Bridge (1883), Madison County, Iowa. Roseman Bridge is an excellent example of nineteenth-century covered bridge construction and a very fine example of a Town lattice truss, one of the most widely used timber bridge designs. Erected in 1883 by county work crews under the supervision of Harvey P. Jones

[131] Covered wood aqueducts were never common, but there were several such structures in the Midwest and noteworthy examples once existed at Johnstown, Pennsylvania and Washington, DC.

(b.1825) and George K. Foster (1831-1886), this is one of five historic covered bridges that survive in Madison County. These bridges exhibit variations to the standard Town lattice truss that appear to have been inspired by a local shortage of large timber. The lattice planks are thinner than usual (2″ instead of the more standard 3″), and a number of the bridges feature a nearly flat roof (instead of a more typical gable roof).[132] Roseman Bridge carried traffic for nearly a century, until it was bypassed in 1981. Madison County restored the structure in 1992. The bridge was featured in the movie adaptation of Robert James Waller's 1992 novel, *The Bridges of Madison County,* and has since become a popular venue for weddings. Roseman Bridge was listed in the National Register of Historic Places in 1976 and recorded by HAER in 2002. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 13.]

Hyde Hall Bridge (1825), Otsego County, New York. Hyde Hall Bridge is highly significant as a rare, early example of a Burr truss with counterbraces in every panel. It is believed to be the oldest extant covered bridge in the United States. This modest, vernacular structure (39′ clear span) was erected in 1825, as part of the construction of Hyde Hall, the George Hyde Clarke (1768-1835) country estate near Cooperstown, New York. Considered one of the finest examples of neoclassical architecture in America, Hyde Hall was designated a National Historic Landmark in 1986, but the boundaries encompass only the main house and associated outbuildings; the covered bridge is not included in the nomination.[133] In 1963, the State of New York acquired the Hyde Hall property for the purpose of developing a state park. The bridge was bypassed in 1965 and restored in 1967. It is currently a pedestrian bridge and historic landmark within Glimmerglass State Park. Hyde Hall Bridge was recorded by HABS in 1961 and HAER in 2002. It was listed in the National Register of Historic Places in 1998. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 14.]

Sunday River Bridge (1872), Oxford County, Maine. Erected by local bridge builder Hiram York (b.1828), Sunday River Bridge is an exceptionally fine example of the truss designed in the 1830s by New England bridge builder Peter Paddleford (1785-1859). The Paddleford truss features a multiple kingpost frame with long counterbraces that overlap the panel points to help distribute loads and increase the structure's rigidity. Though never patented, the Paddleford truss dominated covered bridge construction throughout much of northern New England for more than half a century. Only 20 examples of this truss type survive. This structure served as a public road bridge until 1958, when it was bypassed and preserved in place as an historic landmark and tourist attraction. It has long been known as "Artist's Bridge," as it served as the subject for local artists, most notably John J. Enneking (1841-1916). Sunday River Bridge was listed in the National Register of Historic Places in 1970 and recorded by HAER in 2002. This bridge possesses an unusually high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 15.]

Harpole Railroad Bridge (1922), Whitman County, Washington. Built in 1922 by the Great Northern Railway, Harpole Railroad Bridge is a rare surviving example of a covered railroad bridge and the only surviving example of a boxed through truss bridge in the United States.[134] Many bridges of this type once existed on railroad lines in California, the Pacific Northwest and British Columbia.[135] Harpole Bridge carried freight trains until 1967, when the railroad line was abandoned. In 1969, the adjacent property owners purchased the bridge to better access their farm, as they then used a nearby ford to cross the Palouse River. Harpole Railroad Bridge was listed in the National Register of Historic Places in 1982 as part of the "Historic Bridges and Tunnels in Washington State" thematic resource nomination and was recorded by HAER in 1995

[132] At least seven of Madison County's 19 known covered bridges had this type of nearly flat roof. Historical records suggest that the design was introduced by local carpenter John P. Clark around 1870-71. Clark later worked with H.P. Jones, who continued to use it for the covered bridges he built from 1878 to 1884.

[133] Carolyn Pitts, National Register of Historic Places Inventory-Nomination Form: "Hyde Hall," 1985.

[134] In a boxed truss bridge, each truss is housed separately. See footnote 131 for list of covered railroad bridges.

[135] A similar boxed Howe through truss, Ashnola River Road Bridge (1923), survives on one of the Great Northern Railway's subsidiary lines in British Columbia.

and 2003. The bridge is located in a picturesque rural setting and possesses a high degree of structural integrity. It is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 16.]

Bath-Haverhill Bridge (1829), Grafton County, New Hampshire. Erected in 1829 by an unknown builder, Bath-Haverhill Bridge is an excellent example of nineteenth-century covered bridge construction and one of the oldest covered bridges in the country. It is an early Town lattice truss, one of the most widely used timber bridge designs. Laminated arches were added in 1921-22 to increase the structure's load-carrying capacity. The structure was repaired in 1973 and 1981. The bridge was in service for 170 years; until bypassed in 1999 it carried the traffic of a numbered state highway. It was rehabilitated in 2005-07 at a cost of $1.3 million and is currently open to foot traffic. Bath-Haverhill Bridge was listed in the National Register of Historic Places in 1974 and recorded by HAER in 2002. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 17.]

Doe River Bridge (1884), Carter County, Tennessee. Doe River Bridge is an excellent example of nineteenth-century covered bridge construction and a very fine example of a timber Howe truss, one of the most widely-used timber bridge designs. Built in 1884, this structure played an integral role in the development of the City of Elizabethton, Tennessee, and it is a rare example of a covered bridge that survives in an urban setting. The original contract specified the unusual hip roof design, which resembles covered bridges in central Europe. The structure is very well-maintained and still carries automobile traffic. The bridge was restored in 2003. Doe River Bridge was listed in the National Register of Historic Places in 1973 as part of the "Elizabethton Historic District." It was recorded by HABS in 1965 and by HAER in 2003. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 18.]

Larwood Bridge (1941), Linn County, Oregon. Covered bridge building saw a revival in Oregon during World War I, when steel shortages led the Oregon State Highway Commission to reconsider the use of timber for bridges. Here, county engineers used state-issued plans to build covered bridges into the 1950s. Most of these bridges used a simplified Howe truss without counterbraces. The availability of large-dimension virgin timber allowed builders to return to traditional timber framing practices (e.g. mortising the braces directly into the chords, rather than using angle blocks), and some bridges used hand-hewn single-stick chords, rather than built-up plank chords.[136] Built in 1941 by the Linn County Engineering Department, Larwood Bridge is one of the best surviving examples of the Oregon standard-plan Howe truss bridge. It was one of 46 covered bridges listed in the National Register of Historic Places in 1979 as part of the "Oregon Covered Bridges" thematic resource nomination. It was recorded by HAER in 2003. Larwood Bridge was repaired in 2004 and continues to carry vehicular traffic. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 19.]

Bunker Hill Bridge (1895), Catawba County, North Carolina. Bunker Hill Bridge is an excellent example of nineteenth-century covered bridge construction and the only surviving Haupt truss covered bridge in the United States. Patented in 1839, the Haupt truss featured diagonal braces spanning multiple panels, which was an attempt to eliminate the cross-strain found in lattice truss bridges. Although it was almost immediately eclipsed by the Howe truss and never reached the mainstream of covered bridge building, the Haupt truss is of interest for its association with Gen. Herman Haupt (1817-1905), a nationally renowned engineer, who pioneered the structural analysis of bridges. Bunker Hill Bridge was built by local carpenter Andrew L. Ramsour (1817-1906), who may have been inspired by earlier Haupt truss bridges in the region. The bridge carried local traffic until the 1920s, when it was bypassed and closed to traffic; it continued to carry farm vehicles into the 1930s. The Catawba County Historical Association has maintained the structure since 1985. Bunker Hill Bridge was listed in the National Register of Historic Places in 1971 and was designated a National Historic Civil Engineering Landmark by the American Society of Civil Engineers in 2000. It was recorded by HAER in 2003. This bridge possesses a high degree of integrity and is proposed for National Historic Landmark consideration under Criterion 4. [See photo page 20.]

[136] Some of the single-stick chords found in Oregon covered bridges have impressive dimensions. Pengra Bridge (1938) in Lane County, Oregon has bottom chords measuring 16″x18″x126′.

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Humpback Bridge (1857)
Covington vicinity, Alleghany County, Virginia
James River & Kanawha Turnpike Company, Builder
Multiple kingpost truss

Jack Boucher, Photographer, 1971







Knight's Ferry Bridge (1863)
Knight's Ferry, Stanislaus County, California
Schuylkill Construction Company, Builder
Howe truss

Jet Lowe, Photographer, 2004

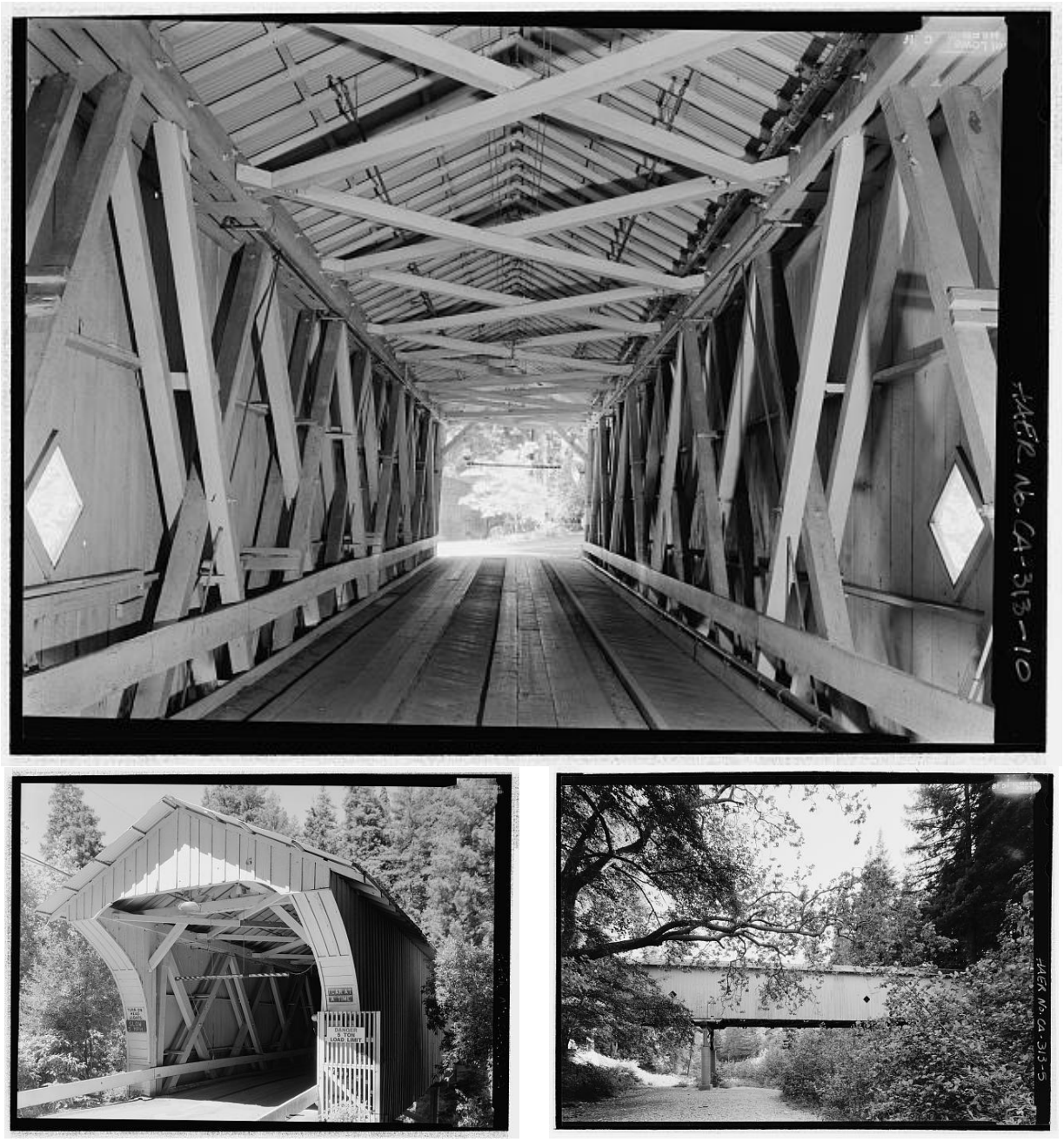






Brown Bridge (1880)
Shrewsbury, Rutland County, Vermont
Nichols M. Powers, Builder
Town lattice truss

Jet Lowe, Photographer, 2003



Powder Works Bridge (1872)
Santa Cruz, Santa Cruz County, California
Pacific Bridge Company, Builder
Smith truss

Jet Lowe, Photographer, 2004







Pine Bluff Bridge (1886)
Bainbridge vicinity, Putnam County, Indiana
Joseph A. Britton, Builder
Howe truss

James Rosenthal, Photographer, 2004

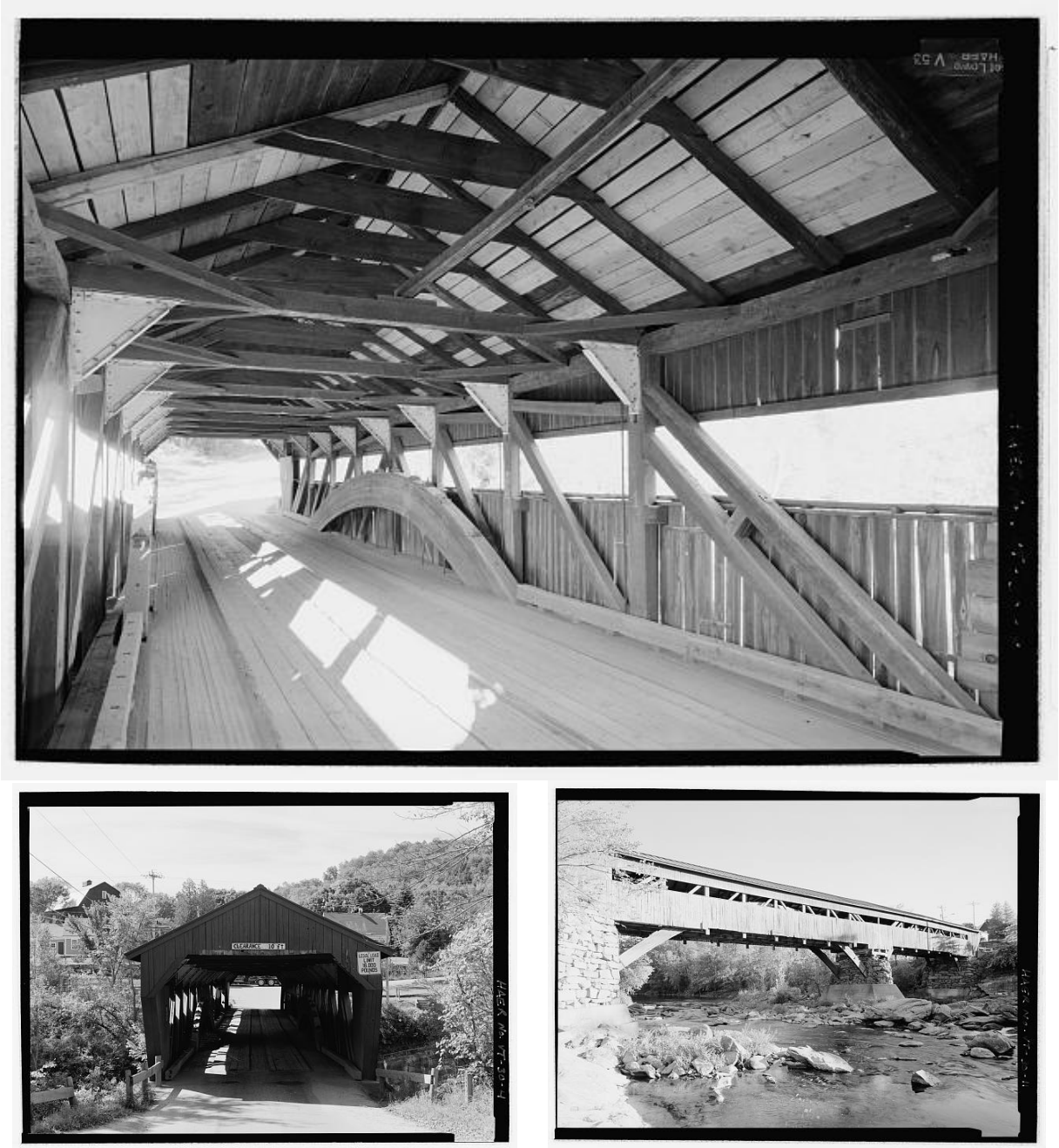






West Union Bridge (1876)
West Union, Parke County, Indiana
Joseph J. Daniels, Builder
Burr truss

James Rosenthal, Photographer, 2004



Taftsville Bridge (1836)
Taftsville, Windsor County, Vermont
Solomon Emmons III, Builder
Multiple kingpost truss

Jet Lowe, Photographer, 2004



Shoreham Railroad Bridge (1897)
Shoreham, Addison County, Vermont
Rutland Railroad Company, Builder
Howe truss

Jet Lowe, Photographer, 2003







Duck Creek Aqueduct (1848)
Metamora, Franklin County, Indiana
Whitewater Canal Company, Builder
Burr truss

James Rosenthal, Photographer, 2005



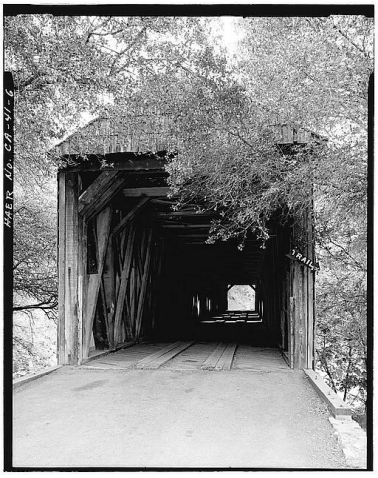




Forsythe Bridge (1888)
Moscow vicinity, Rush County, Indiana
Emmett L. Kennedy, Builder
Burr truss

James Rosenthal, Photographer, 2004







Bridgeport Bridge (1862)
French Corral vicinity, Nevada County, California
Virginia City Turnpike Company, Builder
Howe truss

Jet Lowe, Photographer, 1984







Eldean Bridge (1860)
Troy vicinity, Miami County, Ohio
James and William Hamilton, Builders
Long truss

Jet Lowe, Photographer, 2002



Roseman Bridge (1883)
Winterset vicinity, Madison County, Iowa
Harvey P. Jones and George K. Foster, Builders
Town lattice truss

Jet Lowe, Photographer, 2004







Hyde Hall Bridge (1825)
East Springfield, Otsego County, New York
Cyrenus Clark, Builder
Burr truss

Jet Lowe, Photographer, 2003



Sunday River Bridge (1872)
Newry vicinity, Oxford County, Maine
Hiram York, Builder
Paddleford truss

Jet Lowe, Photographer, 2003







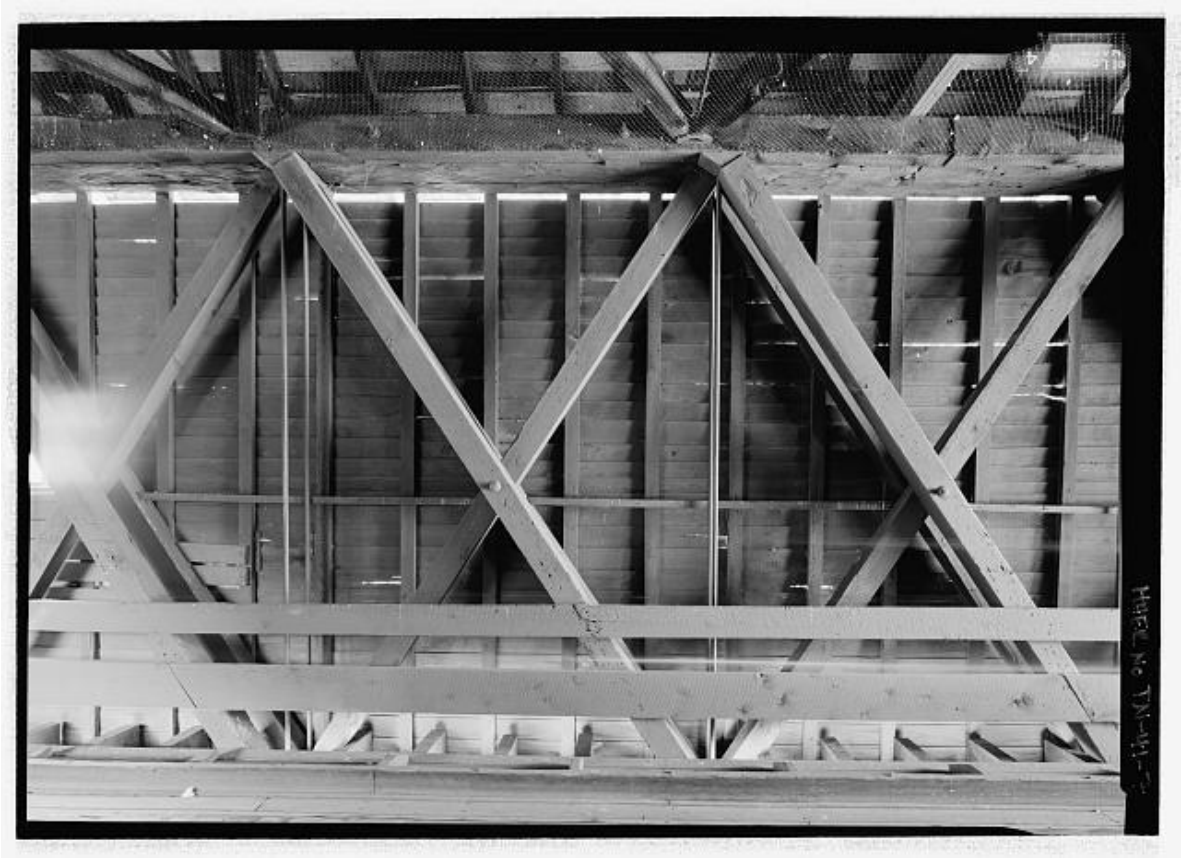
Harpole Railroad Bridge (1922)
Colfax vicinity, Whitman County, Washington
Great Northern Railway, Builder
Howe truss

Jet Lowe, Photographer, 1993



Bath-Haverhill Bridge (1829)
Woodsville, Grafton County, New Hampshire
Builder unknown
Town lattice truss

Jet Lowe, Photographer, 2003







Doe River Bridge (1882)
Elizabethton, Carter County, Tennessee
Thomas Matson, Engineer
E.E. Hunter, General Contractor Howe truss

Jet Lowe, Photographer, 2002



Larwood Bridge (1941)
Lacomb vicinity, Linn County, Oregon
Linn County Engineering Department, Builder
Howe truss

Jet Lowe, Photographer, 2004



Bunker Hill Bridge (1895)
Claremont vicinity, Catawba County, North Carolina
Andrew L. Ramsour, Builder
Haupt truss

Jet Lowe, Photographer, 2002