Waddell "A" Truss Bridge
Spanning Linn Branch Creek
State Route 4
Trimble Vicinity
Clinton County
Missouri

HAER No. MO-8

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
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Historic American Engineering Record

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Waddell "A" Truss Bridge

Location:	Spanning Linn Branch Creek on Missouri State Route 4, approximately 1 mile east of Trimble, Missouri. UTM: 15.368170.4370860 Quad: Smithfield
Date of Construction:	1898; Converted to highway use in 1953
Present Use:	Highway Bridge
Significance:	Designed in accordance with J.A.L. Waddell's patent of November 13, 1894 (#529,220), this is one of only two Waddell "A" truss bridges known to survive in the United States.
Historian/Engineer:	Donald C. Jackson

In 1898, the Quincy, Omaha and Kansas City Railway built the Linn Branch Creek Bridge as part of its line connecting Kansas City with Pattonsburg, Missouri. The line was never a part of any major transportation corridor and primarily served the needs of regional agricultural interests in delivering farm products to market. Following World War I, the Q. O. and K.C. Railway (often referred to locally as the "OK") merged into the Chicago, Burlington and Quincy Railroad system and, in 1939, the line connecting Kansas City and Pattonsburg was abandoned.[1] The Waddell "A" truss bridge over Linn Branch Creek remained unused for over a decade, until 1953, when the Missouri Highway Department placed a new deck on the structure and it became a component of State Route 4. It served as a highway bridge for over 25 years until construction of the Smithville Dam by the Army Corps of Engineers required its removal. At that time, the Corps requested HAER to assist them in documenting the bridge to assure that an archival record of this important type of structure remained for future historical reference.

Fabricated by A & P Roberts Co., in association with the Pencoyd Bridge Co. of Pencoyd, Pennsylvania, the Waddell "A" truss bridge over Linn Branch Creek near Trimble, Mo., is, as of June 1980, one of only two surviving examples of this truss type identified by the Historic American Engineering Record.[2] Designed and patented by the famour American engineer John Alexander Low Waddell, the "A" truss is a significant type of late 19th century, short-span railroad bridge that used pin-connections to join its major structural members.[3] Though only built for a relatively short period of time during the 1890s and early 20th century, the "A" truss was widely used in the Midwest and in Japan. However, beyond its role in the growth of railroad transportation, the "A" truss is perhaps most historically significant when viewed within the context of Waddell's career and the emergence of the American bridge fabrication industry into international marketing.

J.A.L. Waddell was among the most respected American civil engineers of the late 19th and early 20th centuries and he is perhaps best known to historians to technology for his books The Designing of Ordinary Iron Highway Bridges (1884), De Pontibus (1898) and the 2 volume Bridge Engineering (1916). A graduate of Rensselaer Polytechnic Institute in 1875, Waddell quickly distinguished himself as an engineer capable of clearly and concisely communicating thoughts and concepts related to complex technical subjects. During his life, he became one of the world's most influential consulting engineers and was involved in the design and construction of hundreds of bridges around the globe. Beyond this, however, he possessed a deep interest in engineering education and in the early 1880s, served as visiting professor of civil engineering at Tokyo University. It was at this time that Waddell became embroiled in the controversy that ultimately led to his development of the "A" truss for railroad use.

During his stay in Japan between 1882 and 1886, Waddell took careful notice of the bridges then in use on Japanese railroads. They were almost all designed by British engineers and, except for one, all were 100 feet or less in length. For a variety of reasons, Waddell considered them to be inferior to American truss bridges of the time, and he prepared a study published by Tokyo University entitled A System of Iron Railroad Bridges for Japan that strongly criticized British truss bridge design as exemplified in Japanese railroad bridges.[4] Naturally, British engineers took offense at Waddell's criticisms and for several months an American trade journal, The Japan Mail, published an extensive series of letters from British engineers, Japanese engineers, and Waddell concerning the merits and faults of American and British bridges. By the time Waddell returned to American in early 1886, the controversy was by no means resolved, but it was clear that Japanese engineers and the Japanese government had greatly appreciated efforts to increase their understanding of structural technology. This is perhaps best

evidenced by the fact that the Emperor bestowed upon him the rank of Knight Commander in the Order of the Rising Sun for his service to the Japanese nation. However, in leaving Japan, Waddell took much more with him than the appreciation of the Japanese Government. He left with better insight into the problems associated with bridge engineering and a desire to continue development of truss bridge design.

Briefly stated, two of the major characteristics of late 19th century British truss were:

1) they were usually pony trusses, i.e., they were not deep enough to allow lateral bracing to connect the top chords, 2) almost invariably, they exclusively used riveted connections to join their major structural members.

Waddell strongly condemned the use of pony trusses for railroad bridges because the lack of top chord lateral bracing made them weak in resisting wind load as well as susceptible to undesirable vibrations under heavy moving loads. Waddell did not find the riveted connections to be bad per se as long as they were made with proper care and attention, preferably in metal fabricating shops with riveting machines operated by trained workers. Unfortunately, it was impossible to rivet all of a truss' connections in the shop and in the 1880s a riveted truss bridge required a substantial amount of hand riveting to be done in the field, almost invariably in less than optimum conditions. Until the advent of portable pneumatic riveting machines shortly after the turn of the century, Waddell believed the use of pin connections provided more reliable, and easier to erect, truss bridges.

When Waddell returned to America in 1886, he was interested in developing an economical short span, pin connected truss bridge that incorporated strong lateral bracing between the top chords. However, it was not until several years later that he had his opportunity to design such a structure for railroad use.

In his book De Pontibus, he described the design evolution of his "A" truss:[5]

> "For a number of years the author was dissatisfied with all railroad bridges for spans between the superior limit of the plate-girder and a length of about one hundred and fifty feet, ordinary pin-connected, through, Pratt trusses being too light and vibratory, and the riveted bridges as then built being clumsy, unscientific, and uneconomical. On this account he tried for some time to find an opportunity to experiment upon a design of his own to fill a portion of the gap, but the opportunity did not occur until April 1893, when he was retained by the General Manager of the Kansas City, Pittsburg, and Gulf Railroad Company to design some bridges. After a little persuasion, the General Manager was induced to agree to build a 100-ft. "A" truss span as an experiment; but when he saw the completed plans he ordered at once four bridges to be built therefrom, and this style of structure was soon afterwards adopted as the standard 100-ft. span for the road.
>
> These bridges have shown such rigidity under traffic that they have been used on the St. Louis Southwestern Railway, and have been adopted as the standard for spans between sixty-five and one hundred and sixteen feet by the Nippon Railway Company of Japan.
>
> The advantages of this type of bridge are great rigidity in all directions, ease and cheapness of erection, and economy of metal when it is compared with structures of other types having equal strength and rigidity."

Because of its great height, the "A" truss allowed for heavy lateral bracing to be placed between the top chords and resulted in "great rigidity in all directions." Its use of pin connections provided "ease and cheapness of erection" with a minimum of field riveting. Finally, the specific form of the truss, with its (usual) panel lengths of 25 feet, made it cheaper to fabricate than bulky plate girder bridges of equal strength as well as less liable to vibration than ordinary pin-connected trusses of comparable span. The "A" truss thus became Waddell's ideal solution to the problem he originally confronted when criticizing the British-designed Japanese railroad bridges of the early 1880s.

In conclusion, it is important to note that the "A" truss bridge was not a structural type that appeared without precedent. In his patent, Waddell acknowledged that the "A" configuration had been used for roof trusses for many years and he specifically confined his patent to railroad bridges and to structures in which the "A" shaped trusses were connected by lateral bracing. His design was also related to the Kingpost truss, a structural form that had been used for wooden bridges since at least the Middle Ages.

The Waddell "A" truss was not built for a great many years after its initial construction in 1893. With the advent of pneumatic equipment that allowed for fast, efficient and reliable riveting to be done in the field, the need for a rigid, short span, pin-connected bridge became less critical. The Waddell "A" truss never failed to to provide good service, but by 1916 Waddell wrote in his book Bridge Engineering:[6]

> "The "A" truss bridge, patented many years ago by the author, served a good purpose for sometime until the modern Pratt truss bridge was evolved. Quite a few of them were built, and nearly all are still in use, notwithstanding the fact that some are frequently overloaded as much as sixty (60) percent. It is the most rigid short-span, pin-connected bridge ever built. Its appearance is odd but not displeasing."

He was obviously very proud of his design but recognized that the evolution of bridge technology in the early 20th century had already relegated it passe. The "A" truss bridge design represents a significant chapter in the growth and development of one of America's most significant bridge engineers and reflects an important aspect of America's truss bridge heritage. Similarly, the Linn Branch Creek bridge stands as a link to the times when America's iron and steel industry began expanding beyond the limits of the continental United States and American civil engineers began challenging the designs and techniques of Europeans in the international market place. In this context,

the Linn Branch Creek Bridge is a rare and distinctive structure that warrants consideration as a historic bridge of national significance.

FOOTNOTES

[1] A considerable amount of records related to the Q, O and K.C. Railway Company are retained by the Newberry Library in Chicago, as part of their Burlington archives. Reference to this may be found in:

> Elisabeth Jackson and Carolyn Curtis, Guide to the Burlington Archives in the Newberry Library 1851-1901, (Chicago: The Newberry Library, 1949), p. 311.

[2] The bridge fabricator is provided on a nameplate attached to the structure. In the summer of 1980, another Waddell "A" truss was located on the Kansas City Southern Railway in Shreveport, La.. It is practically identical to the "A" truss near Trimble, but it does not have a name or date plate.

[3] Waddell received a patent for his bridge on November 13, 1894 (No. 529,220).

[4] Further information on Waddell's actions in Japan can be found in "Kauai's Opaekaa Bridge: The Only Known British Truss Bridge In the United States" by Donald C. Jackson and Barnes Riznik. This article appeared in Vol. 13, No. 2 (Summer 1978) of Industrial Archeology, published by Graphmitre LTD. of Tavistock, Devon, England.

[5] J.A.L. Waddell, De Pontibus: A Pocket-Book for Bridge Engineers (New York: John Wiley and Sons, 1898), pp. 5-6.

[6] J.A.L. Waddell, Bridge Engineering, 2 Vols. (New York: John Wiley and Sons, 1916), p. 477.

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