NPS Form 10-900-b
(Jan. 1987)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Multiple Property Documentation Form

This form is for use in documenting multiple property groups relating to one or several historic contexts. See instructions in *Guidelines for Completing National Register Forms* (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. For additional space use continuation sheets (Form 10-900-a). Type all entries.

A. Name of Multiple Property Listing

Iron and Steel Bridges in Minnesota

B. Associated Historic Contexts

Historic Iron and Steel Bridges in Minnesota, 1873-1945

C. Geographical Data

State of Minnesota

☐ See continuation sheet

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 for Planning and Evaluation.

Nina M. Archabal — 9/22/89
Signature of certifying official Nina M. Archabal — Date
State Historic Preservation Officer
State or Federal agency and bureau Minnesota Historical Society

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.

Beth Boland — 11/6/89
Signature of the Keeper of the National Register — Date

E. Statement of Historic Contexts

Discuss each historic context listed in Section B.

HISTORIC IRON AND STEEL BRIDGES IN MINNESOTA, 1873-1945

Since its statehood in 1858, Minnesota has been reliant on bridges to maintain the effective transportation system needed to conduct commerce. The earliest bridges in the state were primarily wooden structures, but in the last quarter of the 19th century, iron and steel, materials which became available in large quantities as the United States industrialized, assumed the major role in carrying Minnesota's highways and railroads over rivers, streams, and other barriers. Iron was more common until the 1890s, when steel emerged as the preferred material. Although steel began to give way to reinforced concrete after 1910, it nevertheless, continued to play an important part in bridge building up to the present. This historic context will focus on iron and steel bridges in Minnesota from the time when the oldest surviving iron bridge in the state was built until the end of World War II, when the economy of the state and the nation moved into a new era.

Before European-American fur traders arrived in Minnesota in the early 19th century, the region's transportation network consisted of the trails and water routes of the Indians. The U.S. government established a fort (now Fort Snelling) at the confluence of the Minnesota and Mississippi rivers in 1819, and nearby Mendota soon became a major fur-trading center. Improved trails led from there to the rich fur-trapping areas of the Red River Valley and beyond. Serving the rugged Red River carts, these roads, which were little more than cleared swathes through the landscape, relied on convenient fords for stream crossings. When Minnesota became a Territory in 1849, there were few, if any, permanent bridges within its borders. The territorial legislature immediately authorized boards of county commissioners to maintain roads, license ferries, set toll rates, and build bridges. This coincided with the beginning of rapid settlement of Minnesota. In 1850, Minnesota had a population of 6,077; ten years later, the population was 172,023; and by 1870, the state had grown to 439,706 residents. Most of these people lived in rural areas and needed good roads and bridges to get supplies and to move their produce to market.[1]

AGRICULTURE AND RURAL SETTLEMENT

From small beginnings in the 1840s, agriculture became the state's major economic activity within two decades. The first farmers produced food for their own subsistence and sold some vegetables and grain in nearby settlements. By the end of the 1850s, cash crops had assumed the dominant position. In 1859 farmers in Minnesota grew over two million bushels each of three crops: corn, wheat, and oats. Wheat output increased much faster that of the other two--between 1860 and 1870, it multiplied almost ninefold. Until after the Civil War most agriculture was located in the southern one-third of the state. In the decade after the war, many settlers moved into the Red River Valley, initiating the "bonanza" period, known for its large farms and extensive use of machinery. The predominance of grain growing in the state resulted in related industrial developments, primarily flour milling and the manufacture of agricultural implements in the Twin Cities. While wheat, corn, and oats remained the major crops through the early 20th century, farmers also diversified. They also produced other grains, such as barley and rye, as well as potatoes, orchard fruit, livestock, hay, and dairy goods. Agriculture was a vital economic activity throughout the southern, central, and northwestern sections of the state.[2]

[X] See continuation sheet

RAILROADS

Railroads were essential for creating the existing patterns of settlement and economic development. Their efficient, inexpensive transportation made possible the growth of communities and the establishment of full-scale agriculture, mining, and manufacturing.

The railroad system in Minnesota began as routes connecting towns on the Mississippi River with inland points and other rivers. Although many companies were incorporated or received state charters in the late 1850s, no construction occurred until early in the next decade. With a federal land grant to help pay for a line connecting the heads of navigation on the Mississippi and Red rivers, the St. Paul & Pacific completed a track between St. Paul and St. Anthony in 1862. After construction of a bridge across the Mississippi five years later, it reached Minneapolis. The company fulfilled its mandated goal by reaching Breckenridge in 1871. After changes of ownership and name (St. Paul, Minneapolis & Manitoba Railway. in 1879 and Great Northern Railway. in 1890), it grew to become a transcontinental line. Other lines begun in the 1860s also eventually became parts of major railway systems. Small companies with tracks originating at the Mississippi River towns of Minneapolis, St. Paul, Hastings, Winona, and La Crescent built southwest and west, creating routes later absorbed by the Chicago, St. Paul, Minneapolis & Omaha Railway.; Chicago, Milwaukee & St. Paul Railway.; and the Chicago & NorthWestern Railway. The Minnesota Central Railway. (soon to be part of the Milwaukee system) built a line south from the Twin Cities, providing a link in the first rail route between Minnesota and the important rail center of Chicago, completed in 1867. The first of the four lines connecting Minneapolis/St. Paul and the head of Lake Superior was completed in 1870.[1]

The 1870s included a half-decade of economic depression followed by over a decade of renewed expansion of rail networks. In 1870 the Northern Pacific RR. began construction of a route intended to connect Lake Superior and Puget Sound. It completed tracks west from Duluth into northern Dakota Territory before the Panic of 1873 ended work and brought bankruptcy. Almost all other companies temporarily halted building projects at that time and some also suffered financial ruin. Improvement of the economy in the late 1870s saw the resumption of construction and the emergence of new enterprises. By the turn of the century, almost all the main lines--including projects such as the Chicago Great Western to the south of the Twin Cities and the Minneapolis, St. Paul & Sault Ste. Marie (Soo) to the west--were in place. Railroads continued to add secondary and branch lines into the early twentieth century. As a result, southern, central, and northwestern Minnesota--the main agricultural areas of the state--had dense networks of rail lines.[2]

Most of Minnesota's railroads had extensive tracks and facilities in Minneapolis and St. Paul. Along with Omaha and Kansas City, the Twin Cities were one of the busiest rail centers on or near the eastern edge of the Great Plains. Several companies had their headquarters in large buildings in the Twin Cities. Almost all had switchyards, transfer and industrial tracks, locomotive terminals, freight depots, and shares in union passenger stations. Three major rail routes connected the two city centers. One company--the Minnesota Transfer Railway., based in the "Midway district" of western St. Paul--existed mainly to handle freight traffic between the trunk lines, serving industrial customers as a secondary function.[3]

In addition to building rail lines and support facilities in Minnesota, railways encouraged town settlement and economic development. Rail transportation made the land accessible for large-scale agricultural, industrial and urban growth. Distinct departments and subsidiaries of railroads--such as townsite companies and farm extension services--sought to create new traffic by bringing farmers, merchants, and manufacturers to places along their tracks. In this way, railways helped create the need for new road bridges. The market and banking centers along rail lines depended on networks of rural roads in the surrounding countryside. In the early twentieth century, railways supported the "Good Roads" movement, as they believed it would bring more traffic to their stations and freight yards. Railroads also brought the iron and steel from suppliers and fabricators in industrial centers to the areas of bridge construction.[4]

Although railroads built numerous bridges in Minnesota, almost all are beyond the scope of this project, which deals only with spans which carry, or cross, public roads. Nevertheless, railways had a significant influence on the evolution of vehicular bridge construction in Minnesota. Many of the important bridge designers and builders in the state came to the area as railroad employees, in which capacity they gained their initial experience. Railways also erected some vehicular bridges, such as those over rail lines in cities (Great Northern erected L-8899, 6992, and 92353 over its tracks in Minneapolis).

The decline of the railroads began just after the end of World War I. The popularity and availability of motor vehicles resulted in diminishing local rail passenger and freight business in the 1920s. In the following decades, railways cut services and dismantled tracks. Through the rest of the twentieth century increasingly effective competition continued to cause railway abandonment, while technological changes enabled companies to carry the surviving traffic with fewer tracks and facilities. However, the legacy of the railroads is still apparent in the locations of towns and the facilities which serve economic activities such as grain farming and iron mining.

URBAN DEVELOPMENT

Urban growth in Minnesota began in the 1840s with the establishment of settlements along the Mississippi and lower St. Croix Rivers. At the time of the creation of Minnesota Territory in 1849, the selection of St. Paul as the capital indicated and influenced its urban potential. Nearby, the industrial village of St. Anthony developed as a potential rival. Until the extensive building of railroads in the late 1860s, settlement followed rivers--the Mississippi, Minnesota, and St. Croix--and the shore of Lake Superior. Even after construction of the railways enabled large numbers of settlers to create inland communities, such as Albert Lea, Willmar, and Crookston, this early pattern persisted. Of the ten largest cities in Minnesota at the turn of the century, six were located along the Mississippi, and one each on the Minnesota River, the St. Croix, and Lake Superior. Since the 1850s, the state's most prominent urban center remained the twin cities of St. Paul and Minneapolis.[5]

Most bridges in cities and towns crossed natural barriers, primarily watercourses and ravines. Few, except in the Twin Cities, crossed human-made features, such as railroad tracks. Some towns were located on both sides of a river. Examples range in size from Minneapolis to Cannon Falls in Goodhue County, on the Cannon River. Bridges were obviously important to these communities. The first large bridge in Minnesota, as well as the first permanent span over the Mississippi River, was the suspension bridge, completed in 1855, which linked Minneapolis and St. Anthony. Other bridges replaced and supplemented this early span, making possible the municipal consolidation of the latter into the former in 1872 and the continued growth of Minneapolis through the following century. Most communities along rivers were situated on only one shore. In these cases, bridges served to link them to the rural districts and smaller settlements on the other side. This removed natural obstacles for the rural residents and increased the area over which the merchants and bankers in the larger towns could extend their business.[6]

Beyond the two general scenarios mentioned above, other types of relations between towns and bridges occurred. An example is represented by events at Zumbro Falls in Wabasha County. The first settlement grew in the 1860s on the south bank of the Zumbro River at a ferry landing. In 1878, with the arrival in the area of the first railroad, a new town called Zumbro Falls was platted on the north side of the river and a little to the east. The first bridge, made of pontoons and beam spans, linked the ferry landings and hence was closer to the original community. The two wooden successors to the first span maintained the original alignment. The fourth bridge, constructed of iron in the late 1880s, aroused controversy. Residents of the newer town of Zumbro Falls felt its location should reflect the fact that the local center of population had moved eastward from the early ferry sites. They lost, however, and the iron bridge [No. L-1098] was erected at the same place as the earlier structures.[7]

Road bridges over railroad lines are common in larger cities such as Minneapolis, St. Paul, and Duluth. They can also be found in smaller communities with large rail switchyards. An example is bridge No. 7803 which carries a road over Duluth, Missabe & Iron Range's Proctor Yard in a rural portion of Hermantown. Grade crossings of railway tracks and roads have always been places of danger and inconvenience for both railroads and travellers on roads. They were hazardous spots for pedestrians and motorists, who often underestimated the speed of trains and overestimated their ability to stop quickly. Crossings in urban places caused additional problems, because the stopping and switching of trains on multiple tracks blocked streets for many minutes at a time. In most towns and smaller cities, grade crossings guarded by watchmen or, later, by electronic signals, offered more safety, even if not easing congestion. However, in large urban centers such as the Twin Cities extensive grade separation projects resulted in placing main line tracks either in excavated trenches or on elevated fills. The former occurred in both Minneapolis and St. Paul, resulting in the need for many bridges.[8]

One rail corridor in northern Minneapolis featured four street crossings within the same number of city blocks. After the 1870s, the Manitoba Road (Great Northern after 1890) and the Minneapolis & St. Louis Railway had parallel, adjacent lines running southwest-northeast through the north side of Minneapolis. The five tracks separated the downtown from the northwestern parts of the city, hindering the development of the latter. In the late 1880s, the city proposed that the two railways lower their tracks and build street bridges over the resulting trench. The Manitoba agreed by March 1888, but the M&StL opposed the change. The case reached the Minnesota Supreme Court, which decided in favor of the city. By the early 1890s, the city council had "granted" rights to GN to build specific bridges. The railway constructed four spans on First and Second Streets, Washington Avenue, and Third Street, and remained responsible for their future maintenance. The two which survive--Washington Avenue [No. 6992] and First Street [No. L-8899]-- were altered in the early 1930s, when the GN strengthened the lower chords and lower panel intersections. They represent the legal and engineering problems created by road-railway crossings.[9]

THE FIRST MINNESOTA BRIDGES AND THEIR BUILDERS

Most of the bridges needed in rural Minnesota were relatively short of span. Some of the major rivers, especially the St. Croix, the Minnesota, and the Mississippi, required much larger structures. In the mid-19th century, small bridges were usually built by local contractors (often farmers acting as contractors) and were rather crude affairs, typically comprised of an unsophisticated superstructure supported by an unsound substructure. Rarely did these bridges last more than a few years, either collapsing under a heavy load or washing away in a spring flood. It was not uncommon that a nearby farmer would repair or rebuild a bridge in lieu of paying his road taxes, and the result was usually as shaky as the original.[10] Nevertheless, rural residents had to make due with the situation until an improved system, in the form of contractors specializing in bridge construction, arrived on the scene in the 1860s and 1870s.

To bridge the major rivers, Minnesotans relied on individuals with some expertise in engineering and the construction of large structures. Moreover, such projects typically cost more than nascent local governments could afford. Thus private bridge companies emerged to build bridges, selling shares of stock to raise construction capital, and then charging tolls to cover operating expenses and shareholder dividends. During the three-year period ending in 1857, fifteen bridge companies were incorporated in Minnesota to build and operate at least as many large bridges. One of the most notable of these privately-owned spans was the Hennepin Avenue Suspension Bridge built by the Mississippi Bridge Company in 1854-55. The structure crossed the Mississippi River, linking the cities of Minneapolis and St. Anthony. Designed by Thomas M. Griffith, who had participated in the construction of a suspension bridge over Niagara Falls in 1850, the bridge featured a 640-foot span hung from wire cables supported by wooden towers.[11]

Other large Minnesota bridges of the 1850s crossed the St. Croix River at Taylor's Falls and the Mississippi River at St. Paul (at the site of the present Wabasha Bridge), St. Cloud, and Little Falls. By the end of 1858, there was a total of three bridges over the Mississippi in Minneapolis.[12] Joseph S. Sewell designed both the St. Paul bridge and the span at Taylor's Falls, the latter a 150-foot wooden arch structure. The St. Paul bridge, on the other hand, was a 1300-foot, nine-span Howe truss of wood and iron.[13] The Howe truss (described on page 7) was the most common structural type for long-span bridges in Minnesota prior to the introduction of all-iron bridges around 1870. With the exception of the suspension bridge in Minneapolis and the wooden arch structure at Taylor's Falls, the other major bridges built in Minnesota during the 1850s were probably Howe trusses as well.

As the need for larger bridges in Minnesota increased, so did the activity of out-of-state bridge builders. In 1856-1857, for example, Stone, Boomer, and Boyington of Chicago received $50,000 for constructing the 1000-foot, multi-span, truss Lower Falls Bridge, located about one mile below the suspension bridge in Minneapolis.[14] This marked the beginning of a period during which local governments and private bridge companies awarded many, if not most, of the contracts for larger bridges to construction firms from other states. This trend was facilitated by the beginning of the railroad era in Minnesota in the 1860s, which soon brought about the possibility of direct and rapid transportation of manufactured materials from more industrialized centers in the east. This trend would not be reversed until the late 1880s when several Minnesota bridge builders established themselves and the state developed its own industrial capacity.

Although out-of-state companies captured much of the bridge building business in Minnesota during the period from the early 1860s to the end of the 1880s, there were several important Minnesota contractors as well. Silas Barnard of Mankato gained a sound reputation around 1870 for his numerous wood and iron Howe trusses in Blue Earth and the surrounding counties.[15] An even more important career was that of Horace E. Horton of Rochester. Horton built his first bridge, a wood arch span over the Zumbro River in Olmsted County, in 1867. He went on to build numerous smaller bridges throughout Minnesota and the neighboring states. He also built several of the larger bridges in Minnesota during the 1880s, before relocating and forming the Chicago Bridge and Iron Company in 1889.[16]

THE IRON AND STEEL BRIDGE ERA

In the 1860s and 1870s, several national bridge building companies gained their reputations by adapting wrought iron to the task of comprising bridge superstructures. Their new bridge designs followed two trends of engineering and industrial development. The first involved the design and patenting of efficient and reliable trusses, primarily of wood, but also of wood and iron (the latter used for tension members). Several 19th century engineers developed trusses which were used in a variety of applications, usually experimental and limited. The three most important patents were the Howe truss (William Howe, 1840), which consisted of diagonal members in compression and vertical members in tension; the Pratt truss (Thomas and Caleb Pratt, 1844), comprised of vertical members in compression and diagonal members in tension; and the Warren truss (developed in the United States by Squire Whipple in 1849 without knowledge of James Warren's invention of the same truss in England the year before), which had diagonals in both tension and compression. In the 19th century, the Howe truss was the most commonly used wood truss; by the late 19th century, when iron and steel replaced wood for longer spans, the Pratt became the most widely used truss. In the 20th century, after the riveted connection replaced the pin-connection as standard practice, the Warren truss became more frequently used for steel bridges. The Warren's first wide use was for pony trusses; it later received extensive use for the longer spans, previously served by the Pratt through truss, as well.[17]

At about the same time as engineers were experimenting with various truss configurations, others were attempting to employ iron for bridges. Two types of iron, cast and wrought, were used in bridges. Cast iron contains more carbon than does steel and includes other impurities. As its name implies, it is usually cast into required shapes. Its brittleness makes it unsuitable for forging and rolling. The collapse of the Ashtabula Bridge in Ohio in 1876 ended the use of cast iron in bridges. Wrought iron is nearly pure, containing only a tiny amount of slag. It can be easily worked and is used for forging and blacksmith work. In the mid-19th century, mills rolled wrought iron, in the same manner as steel, to produce structural shapes such as I-beams, channels, angle sections, and plates. Wrought iron remained the principal bridge-building metal into the late 19th century. After the Civil War, the adoption of the Bessemer converter made possible the production of large amounts of steel at low cost. Bridge builders, however, used Bessemer steel in limited quantities. Large-scale open-hearth steel production beginning in the 1890s made steel the preferred material. Wrought iron disappeared from bridge work by the mid-1890s.[18]

Initially iron bridges were built entirely of cast iron, or they utilized cast iron for compression members and wrought iron for tension members. By the 1850s, most engineers recognized that the brittleness of cast iron made it unreliable even for compression members in bridge trusses. In that decade, rolled shapes of wrought iron, such as angle and channel sections and I-beams, became available on the American market. The Keystone Bridge Company of Pittsburgh was one of the first to use wrought iron for all members of its bridge trusses. The Phoenix Iron Company of Phoenixville, Pennsylvania, developed a tubular girder of wrought iron shapes which was excellent in compression, shear, and bending. In the 1860s, several engineers, such as Zenas King of Cleveland, Ohio, and David Hammond of the Wrought Iron Bridge Company of Canton, Ohio, developed tubular arch, or bowstring arch, truss bridges, all generally derived from the masonry arch. King's tubular arch was rectangular in section, while Hammond employed the Phoenix tubular girder, which was circular in section. Bowstring arch bridges suffered from a number of technical problems, however, and by the end of the 1870s their use had largely ended.[19] By the 1880s, the wrought iron, pin-connected Pratt through truss had become the standard structural type for long-span bridges in Minnesota.

The influence of out-of-state bridge builders became especially pronounced with the introduction of iron bridges to Minnesota around 1870. Zenas King of Cleveland, Ohio, built one of the first iron bridges in the state (one newspaper account stated that "this is evidently not the first one of its kind in Minnesota") over the Rum River at Anoka in 1870. Both 100-foot spans were patented King's Tubular Arches and rested on stone abutments and a stone pier. The bridge cost $14,000, of which $7,000 came from an appropriation by the Minnesota legislature.[20] Although this bridge was only one-fifth the length of the wooden Howe truss Lower Falls Bridge in Minneapolis, it cost more than one-fourth as much. This higher cost for an iron bridge was typical, but builders argued that the greater first cost was justifiable in the long run due to the superior strength and durability of an iron bridge.[21] Although several other iron bridges attracted notice in Twin Cities newspapers, such as spans over the Cannon River at Northfield in 1872 and Cannon Falls in 1874, the wood-and-iron Howe truss remained the most widely used structural type through the 1870s. For example, in 1873, the City of Minneapolis built an wood-and-iron, 1560-foot, multi-span, Howe truss bridge over the Mississippi at Eighth Avenue North.[22]

Blue Earth County played an especially notable role in bringing iron bridges to Minnesota. The county experienced its first great surge of settlement during the 1860s, with the population growing from 4,803 in 1860 to 17,302 ten years later. The arrival of the railroad in 1868 helped to spur this growth.[23] Because of the numerous rivers and their tributaries, which flow through the county towards the Minnesota River at Mankato, the county and its townships required an especially large number of bridges to carry people and goods to and from market and railroad centers. Embarking on a program to build high quality, permanent bridges in the late 1860s, the county first turned to iron in 1872. In response to a request for bids to build a bridge over the LeSueur River in Decoria Township, four out-of-state contractors submitted plans and costs for their respective iron bridges. Silas Barnard (already noted as the local contractor for substantial Howe truss bridges) submitted a bid for a wooden Howe truss. Three of the five commissioners were appointed as a committee to examine the suitability of iron bridges and to award the contract if they approved of the new material. They selected the proposal of the Wrought Iron Bridge Company of Canton, Ohio, whose bid in this case was even lower than that of Barnard.[24]

The following February, 1873, the Minneapolis Tribune reported that "the Commissioners of Blue Earth County are going to re-bridge the county. The entire system has been declared a fraud and the necessity of doing work all over decided upon."[25] From that point until the end of the century, every bridge built by the county (townships still had the responsibility of building smaller bridges) except two wood bridges (1875 and 1881) were built of iron or steel.[26] The county built the first bridge in this campaign in 1873 over the LeSueur River in South Bend Township near the John Kerns farm. Once again, the Wrought Iron Bridge Company was low bidder, at $6000, and received the contract for the superstructure.[27] The Kerns Bridge [No. L-5669], which still stands at its original location, is a 190-foot, single-span, wrought iron, bowstring arch truss. It is the oldest surviving bridge (with good integrity) in Minnesota.[28] Although the Wrought Iron Bridge Company also bid on the next Blue Earth County bridge, constructed over the Watonwan River in Garden City Township in 1874, the King Iron Bridge and Manufacturing Company (as Zenas King called his firm after 1871) of Cleveland submitted a lower bid and received the contract.[29]

The commissioners awarded subsequent contracts for iron bridges in the 1870s to such contractors as the Keystone Bridge Company of Pittsburgh, Soulerin, James and Company of Milwaukee, Horace E. Horton, as well as to the Wrought Iron Bridge Company.[30] The 1875 bridge erected by Soulerin, James and Company over the Blue Earth River at Vernon Center now stands in a park in LeSueur County [No. 4846]. Leon Soulerin and Garth W. James established a bridge-building firm in Milwaukee in 1870. Two years later, the firm was known as the Milwaukee Bridge & Iron Works, although it evidently still bid on projects, such as the Blue Earth County job, under the name of Soulerin, James and Company. By 1877, both men had left the Milwaukee Bridge & Iron Company.[31] The 1875 bridge which Soulerin, James and Company built at Vernon Center is the oldest surviving Pratt truss bridge in Minnesota.

Early Bridge Builders

Although Horace E. Horton became a major bridge builder in the 1880s, out-of-state companies apparently continued to dominate the bridge construction market in Minnesota through that decade.[32] Surviving wrought iron bridges from the 1880s include the 1888 Hennepin Avenue Bridge [No. 90589] over the Mississippi River in Minneapolis, built by Horton and the Wrought Iron Bridge Company;[33] the 1890 Wabasha Street Bridge [No. 6524] over the Mississippi in St. Paul,[34] and the 1889 Zumbro River Bridge [No. L-1098] at Zumbro Falls,[35] both built by Horton; the Merriam Street Bridge [No. 27664, formerly part of the 1887 Broadway Avenue Bridge] in Minneapolis built by the King Bridge Co.; the 1885 Hannover Bridge [No. 92366] over the Crow River between Hennepin and Wright counties built by the Morse Bridge Company of Youngstown, Ohio; and the 1883 Kennedy Bridge [No. L-5665] over the LeSueur River in Blue Earth County,[36] and the 1888 Marshall Avenue/Lake Street Bridge [No. 6520] over the Mississippi River between St. Paul and Minneapolis,[37] both built by the Wrought Iron Bridge Co. The out-of-state bridge contractors, however, provided valuable experience to their agents who were resident in

Minnesota, and several of these men would, in the 1890s, establish their own bridge-contracting firms. Although out-of-state companies would continue to play an important role in bridge construction into the 20th century, Minnesota-based builders soon dominated the market.

Seth M. Hewett and Commodore P. Jones were two of the early Minnesota bridge builders to establish their own firms. Hewett and Jones assume added importance because, unlike Horton, who moved to Chicago, they played out their careers in Minnesota. Moreover, they provided early employment for several of the state's more prolific or significant bridge builders. Jones began his career as a bridge builder in Minneapolis around 1880. Little else is known of his background. Hewett had been in the lumber trade in Iowa in the 1870s, building a few bridges to supplement his business, before moving to Minneapolis in about 1882. By linking the lumber business with contracting, he was typical of many bridge builders of the period. For a brief time, 1883-1884, the two men formed a bridge contracting partnership called Jones and Hewett. Agent for the firm was Alexander Y. Bayne, an individual who would be important in Minnesota bridge building over the next four decades. After the partnership dissolved, Jones and Hewett each continued long carriers erecting bridges in Minnesota and throughout the region as far west as Montana.[38] No bridges survive in Minnesota from the Jones and Hewett partnership.

After leaving the partnership, Hewett became an agent for the Smith Bridge Company of Toledo, Ohio, and he formed the Minnesota Stone Company to build stone bridges and stone foundations for wood or iron bridges. In 1887, Hewett left the Minnesota Stone Company and started his own S.M. Hewett and Co. Two nephews from his hometown of Hope, Maine, William S. Hewett and Arthur L. Hewett, came to Minneapolis to work for the elder Hewett. William formed his own W.S. Hewett and Co. in 1897, with his cousin Arthur joining him as agent. Perhaps in response, Seth Hewett changed the name of his company to the Hewett Bridge Company, which continued building bridges through the first decade of the 20th century.[39] Two of S.M. Hewett's truss bridges are known to survive, the 1893 Albright Mill Bridge [No. 90684] in Middleville Township[40] and the 1893 North Fork Bridge [No. L-8123] in Marysville Township,[41] both over the North Fork of the Crow River in Wright County. Also still standing is the Kingston Township Bridge [No. 90980] over the North Fork of the Crow River in Meeker County, built by the Hewett Bridge Company in 1899.[42]

Jones started his own Jones Bridge Company after leaving the partnership with Hewett. Bayne stayed with him as agent and Milo A. Adams, another bridge builder of late 19th and early 20th century importance, was his foreman. In 1887, Jones became involved in the Minnesota Stone Company and formed his own Minneapolis Bridge Company. In subsequent years, Jones would be an agent for the Milwaukee Bridge and Iron Company and form yet another firm, the Minneapolis Bridge and Iron Company.[43] Four bridges of the Minneapolis Bridge and Iron Company are known to survive in Minnesota: the Medelia Township Bridge [No. 6527] over the Watonwan River and the Long Lake Township Bridge [No. L-8044] over the South Fork of the Watonwan River, both built in 1908 in Watonwan

County, and the 1903 Ulen Bridge [No. L-8344] over the South Branch of the Wild Rice River and the 1908 Highland Grove Bridge [No. L-8367] over the Buffalo River, both in Clay County.[44] In 1911, Jones and Seth Hewett reunited in a firm called the Great Northern Bridge Company.[45] At least four bridges erected by this company are known to survive: the 1912 Clearwater River [No. L-0817] in Red Lake County, and the 1911 Otter Tail River Bridge [No. 198], the 1917 Red River Bridge [No. 90021], and the 1922 Red River Bridge [No. 3609], all in Wilkin County.[46]

Apparently, Bayne and Adams were among the more prolific bridge builders in Minnesota, both on their own behalf and on behalf of the companies for which they worked.[47] Adams had moved to Minneapolis to work on construction of James J. Hill's Stone Arch Bridge over the Mississippi River. After working with Jones, he became the travelling agent for the King Bridge Company, serving Minnesota as well as a region as far west as Montana. Around the turn of the 20th century, as the King Bridge Company became less active in Minnesota, Adams formed his own M.A. Adams Bridge Company, which he headed (with a minor name change to the M.A. Adams Company in 1914) until his death in 1922.[48] More than ten of Adams bridges are known to survive in Minnesota, the oldest of which is the 1904 Upper Plum Creek Bridge [No. L-6913] in North Hero Township of Redwood County[49] and the longest of which are the 1915 Cannon River Bridge [No. 1324] in rural Red Wing and the 1916 North Branch Bridge [No. 2129] on the outskirts of Mazeppa in Wabasha County.[50] Another important M.A. Adams bridge is the 1910 Cottonwood River Bridge [No. L-6881] in Redwood, an early example of a riveted Warren through truss built during the period when the pin-connected Pratt through truss was the preferred truss type for comparable spans (120 feet).[51]

Following his tenure as agent for C.P. Jones, A.Y. Bayne briefly went into business for himself before becoming manager of the new bridge department of the Gillette-Herzog Manufacturing Company in 1890. He stayed with that company for ten years until it merged with 23 other companies from around the United States to form the giant American Bridge Company. Bayne served as manager of the contracting department of the American Bridge Company's Gillette-Herzog branch for about three years before establishing his own firm, A.Y. Bayne and Company, in 1903.[52] Bayne's surviving Minnesota bridges include the 1906 Bear Creek Bridge [No. L-4885], the 1909 Deer Creek Bridge [No. 7970] and others in Fillmore County; the 1909 3rd Street North Bridge [No. L-5391] over the Cannon River in Cannon Falls, and the 1904 Walcott Township Bridge [No. L-2733] over the Straight River in Rice County.[53] In 1914, Bayne formed a new Minneapolis Bridge Company (neither of C.P. Jones earlier companies with a similar name existed by this time)[54] surviving bridges of which include the 1920 Iberia Bridge [No. 3279] over the Cottonwood River in Brown County,[55] the 1914 Bear Creek Bridge [No. L-4883] in Fillmore County,[56] and the 1931 Wabasha Bridge [No. 4588] over the Mississippi River.[57]

In 1908, Bayne and William S. Hewett formed a brief partnership. Only one of their joint projects is known to survive, the Minnesota Soldiers Home Bridge over Minnehaha Creek in Minneapolis [No. 5756]. A three-hinged steel arch with braced spandrels, the bridge was designed and erected by Bayne and Hewett with steel fabricated by Minneapolis

Steel and Machinery. Hewett was probably the design engineer for the project, because in other phases of their careers, he engaged in a variety of design efforts, while Bayne was known strictly for his construction superintendence.

William S. Hewett and Company had prospered since he left his uncle's company in 1897, securing bridge construction contracts throughout Minnesota and a several-state region. In 1906, William and his cousin, Arthur Hewett, re-organized to form the Security Bridge Company, headquartered in Minneapolis.[58] During this period, William turned much of his attention away from bridge contracting and toward a number of engineering design efforts, such as the Soldiers Home Bridge. Another important job was his 1905 design for the strengthening of the Marshall/Lake Bridge [No. 6520] over the Mississippi River between Minneapolis and St. Paul. Hewett was also important for his contributions to the development of improved technologies for the use of concrete. Since the 1890s, he had participated in several experimental re-inforced concrete bridge projects (employing the Melan-type concrete arch). He patented a pre-cast concrete culvert which, could be assembled in sections, called the Security Culvert. Perhaps William Hewett's most noteworthy innovation was a means of using pre-stressed concrete for the construction of large concrete water tanks, for which he is credited as one of the originators of pre-stressed concrete technology.[59]

Several William S. Hewett and Company bridges survive, including the 1904 Seaforth Bridge [No. L-6930] over the Redwood River in Redwood County; and the 1897 pin-connected Pratt pony truss span which was moved to the Zumbro Bottoms Bridge [No. L-1130] over the Zumbro River to serve as an approach span, and the 1906 Elgin Township Bridge [No. L-1170] over the North Fork of the Whitewater River, both in Wabasha County.[60] With William devoting less attention to bridge contracting, Arthur Hewett became president of the Security Bridge Company and moved its headquarters to Billings, Montana in 1911. Nevertheless, the Security Bridge Company was quite active building bridges in Minnesota prior to that time. Three Security bridges known to survive in Minnesota are the 1907 Cottonwood Street Bridge [No. 246] over the Cottonwood River in New Ulm, the 1907 Phelps Mill Bridge [No. L-0885] over the Otter Tail River at Phelps Mill, and the 1910 Miller Creek Bridge [No. 2128] in Wabasha County.[61]

One other important Minneapolis-based bridge builder was Lawrence H. Johnson. Born in Germany, he moved to Minneapolis in 1883 to work for C.P. Jones' old Minneapolis Bridge Company, after which he served as an agent for the Milwaukee Bridge and Iron Company, the Wrought Iron Bridge Company, and the Wisconsin Bridge and Iron Company. In 1905, Johnson formed the Hennepin Bridge Company, which was active in a region extending from Wisconsin to Montana. From 1901 to 1909, he also served in the Minnesota legislature, and he was the speaker of the house in 1907.[62] The only bridge surviving in Minnesota Johnson is known to have built is the 1903 Delhi Bridge [No. 89850] over the Minnesota River between Redwood and Renville counties. He built the bridge two years before forming the Hennepin Bridge Company.[63]

In addition to the Minneapolis-based bridge builders, whose markets extended beyond Minnesota's borders, there were other contractors who were locally important. For example, the Fargo Bridge and Iron Works of Fargo, North Dakota, built several bridges for local governments in northwestern Minnesota. Established in about 1905 by Francis E. Dibley, with Elmer H. Stranahan as his agent, the Fargo Bridge and Iron Works was able to win some bids in northwestern Minnesota, no doubt because of its geographical proximity relative to Minneapolis. A surviving Fargo Bridge and Iron Works bridge is the 1907 Kragnes Bridge [No. 90818] over the Buffalo River in Clay County, which is across the Red River from Fargo.[64]

Bridge Engineers

William S. Hewett was important as a bridge builder and as a bridge engineer. Bridge engineers had continued to play a major role in the design of Minnesota bridges through the end of the 19th century, but it was not until 1905-1911, with the creation of the Minnesota Highway Commission, that engineers were involved in virtually every bridge construction project. Prior to that time, only the largest bridges and the largest local governments enjoyed the services of professional engineers. Because they were the two largest cities in the state and both spanned the Mississippi River, Minneapolis and St. Paul were among the first to hire engineers as city employees. These engineers designed a wide assortment of smaller bridges for creek and railroad crossings as well as the giant structures which carried traffic over the Mississippi. The works of Thomas Griffith and Joseph Sewell, two consulting engineers, have already been described. City engineers also completed important designs in the Twin Cities.

Leonard W. Rundlett was the city engineer for St. Paul for a lengthy period around the turn of the 20th century. Born in Maine in 1846 and educated at Bowdoin College, he came to St. Paul in the early 1870s to work as a surveyor for the St. Paul and Pacific Railroad. In 1874 he became assistant city engineer and soon thereafter the city engineer for St. Paul. Rundlett remained in office until 1911 and died in 1916.[65] The City Bridge Engineer in Rundlett's office was Andreas W. Munster, who held that position from 1884 to 1906.[66] The office was responsible for conventional bridge designs, like the 1900 Raymond Avenue bridge [No. 90402] over the Great Northern tracks, as well as bridges which demonstrated significant expertise in structural engineering. Rundlett's office designed two such bridges in the late 1880s which still stand, the Selby Avenue bridge [No. 62501] over the tracks of the Milwaukee Road and the Wabasha Street Bridge [No. 6524] over the Mississippi River. The Selby Avenue bridge is notable because of its extreme skew relative to the tracks, the consequent offset of the middle piers, and the manner in which Rundlett designed the truss spans to accommodate those conditions. The Wabasha Street bridge is an important cantilever structure, comparable to other large, late 19th-century cantilever bridges built over the Mississippi at downstream locations in Minnesota and Iowa.[67]

In Minneapolis, the city engineer for many years was Andrew Rinker, whose career milestones closely paralleled Rundlett's. Born in Philadelphia in 1849, Rinker moved to Minneapolis in 1871. There he practiced civil engineering and surveying with George Cooley until becoming city engineer in 1877. Except for a brief stint in private practice between 1895 and 1903 (working as an engineer and officer of the Great Falls Water Power and Townsite Company in Montana), Rinker worked for Minneapolis until becoming the engineer for the Twin Cities Rapid Transit Company in 1916, two years before his death.[68] Two bridges known to be designed by Rinker's office survive, the Hennepin Avenue bridge [No. 90589] over the Mississippi River and the Merriam Street bridge [No. 27664], which is comprised of one span of the former Broadway bridge [No. 2722] over the Mississippi. The Hennepin Avenue bridge, built between 1887 and 1891, is an important, two-span, steel arch deck bridge with unbraced spandrel vertical members.[69] The Merriam Street bridge is the last remaining, 19th-century, Pratt through truss span from a vehicular bridge over the Mississippi River in the Twin Cities. Although several Twin Cities bridges had other configurations, such as the steel-arch Hennepin Avenue bridge or the cantilever deck-truss Wabasha Street bridge, the multi-span Pratt through truss was often used to span the Mississippi until the advent of reinforced concrete arch construction in the early 20th century.[70] An important innovator of reinforced-concrete arch bridge design was Frederick Cappelen, who served as assistant to Rinker and as city engineer during Rinker's absence and following his retirement. Cappelen participated in the design of the Hennepin Avenue Bridge.[71]

At least one major vehicular bridge over the Mississippi in the Twin Cities, the Marshall Avenue/Lake Street Bridge, was not designed by either of the city engineers' offices, but rather by a private consulting engineer, Joseph Sewell. Located along the border between Ramsey and Hennepin counties, the bridge was jointly financed by the two counties which granted ownership of the bridge to their respective cities shortly after the Wrought Iron Bridge Company had completed construction.[72] Sewell, whose contributions as an engineer to early Minnesota bridge construction have already been noted, was followed later in the century by several other consulting engineers who specialized in bridge design, such as the firm of Loweth and Wolff. Charles F. Loweth began working as a bridge engineer in St. Paul and as an agent for bridge companies in the early 1880s. He was a foreman for H.E. Horton in the late 1880s and briefly joined Horton in Chicago to work for the Chicago Bridge and Iron Works. In 1901, Loweth joined with Louis P. Wolff to form an engineering firm which designed both highway and railroad bridges. Prior to joining Loweth, Wolff had been the Red Wing city engineer and had worked with Loweth in designing the bridge over the Mississippi at Red Wing. Loweth and Wolff targeted local governments as a market for their engineering services by offering to assist local governments in designing bridges which complied with early Minnesota Highway Commission specifications (see discussion below).[73]

Since the establishment of the State Highway Commission, professional engineers, both as government employees and in private practice, have continued to play an important role in the design and construction supervision of bridges which safely and effectively meet Minnesota's ever-changing needs.

Suppliers and Fabricators

The erection of iron and steel bridges was preceded by two distinct manufacturing processes--the reduction and rolling of the metal, and its fabrication into pieces appropriate for bridge assembly.

Bridge iron came from foundries and rolling mills. After reduction of the combined iron ore, coke, and limestone (flux) in blast furnaces, the resulting pig iron could be remelted and poured into molds to create cast iron shapes. To make wrought iron, puddlers stirred the molten pig iron to remove impurities. The product could then go a forge shop or rolling mill.

Steel began like iron, with ore, fuel, and flux in blast furnaces at integrated steel mills. The resulting pig iron became steel in open-hearth furnaces. Then rolling mills produced I-beams, channel and angle sections, plates, bars, and other structural pieces. The steel used in bridges recorded in this survey came from throughout the main steel-producing belt of the nation: Pennsylvania and the states next to the Great Lakes. I-beams and channel sections marked "ILLINOIS" (made at South Chicago) and "CARNEGIE" (rolled in Pittsburgh) were most commonly observed. The United States Steel Corporation absorbed both of these companies and their mills in 1901. Less frequently seen were products of Cambria (Johnstown, Pennsylvania), Inland (East Chicago), and Jones & Laughlin (Pittsburgh). Bridges often included steel from two or more mills. Bridge No. 77--in rural northwestern Olmsted County; built in 1911--has structural components from the Carnegie, Cambria, and Eastern steel companies (the last in Pottstown, Pennsylvania). Although Minnesota had at various times two steel mills--in Duluth and Minneapolis--and Superior, Wisconsin had one, no products from these were observed.[74]

Fabricators bought standard lengths and sizes of rolled steel products and fashioned them into bridge parts. Their plants were large industrial complexes including several distinct functions. After receiving an order for a bridge, clerical staff arranged contractual and shipping details while the engineering department prepared detailed plans, lists, and instructions for fabrication and erection. The template shop made or used already existing wood patterns, which guided the workers in the riveting shop, who cut, punched, and bored the steel. They also did as much assembly as was possible, riveting together chord members, struts, and other built-up sections which would be transported to the bridge site for completion. For pin-connected bridges, two other departments were also important. The machine shop turned the pins, as well as doing other planing and finishing. The forge shop produced eye-bars and other items requiring foundry and blacksmith work. Additional features of a fabrication plant included a power plant, offices, and storage.[75]

Companies which fabricated bridges also prepared and built other large features. Their facilities for and experience in engineering and preparation of steel made it logical that they also did business concerning other metal-framed structures. Companies which listed themselves as bridge fabricators also advertised water towers, tanks, steel-framed buildings for industrial and commercial functions, power plants, roof trusses, and mine headframes.[76]

Of the bridges in this survey with known fabricators (25 out of 95 total), most were prepared outside of Minnesota. Like the mills which rolled the steel, almost all fabricators noted in this project were located in the Great Lakes region and Pennsylvania. Those known to have fabricated two or more bridges in this survey include the American Bridge Company (main plant at Ambridge, Pennsylvania; one of its secondary plants in Minneapolis), Central States Bridge Company (Indianapolis), Keystone Bridge Company (Pittsburgh), King Bridge Company (Cleveland), and Wrought Iron Bridge Company (Canton, Ohio). All of these, except for the Keystone Bridge Company, also served as the contractor for their bridges.

Some bridge fabrication occurred in Minneapolis and St. Paul. Along with flour milling, lumber manufacturing, printing, and railroad equipment repair, companies in the related fields of structural and ornamental iron and machine and foundry work were among the largest industrial employers in the Twin Cities. Of the two, Minneapolis had more companies and employees doing this work. For example, in 1905, seven firms there engaging in structural and ornamental iron work had 854 employees, compared to four companies in St. Paul with 459 workers.[77]

At least three Twin Cities companies did their own bridge fabrication. One of the largest concerns was the Gillette-Herzog Manufacturing Company. It had a large plant in Minneapolis at Seventh Avenue and Second Street Southeast. Gillette-Herzog fabricated structural steel for industrial buildings and structures throughout a region ranging from Michigan to the Gulf of Mexico to the Pacific coast. In 1900-1901, just before its absorption into U.S. Steel's American Bridge Company, it employed, at three different times during the year, 480, 310, and 270 people. Of all the iron, foundry, and machine work firms in the Twin Cities at this time, only the Minneapolis Threshing Machine Company had more employees. Gillette-Herzog also erected many of the bridges for which it fabricated steel. The most elaborate of the surviving Gillette-Herzog steel trusses is the 1899 Forestville Bridge [No. 6263] in Fillmore County. A pin-connected Pratt through truss span, it has ornate iron cresting along the top edges of the portal bracing.[78]

After the American Bridge Company took over the Gillette-Herzog plant, the Gillette family started a new business, the Minneapolis Steel and Machinery Company, in which bridge fabrication and construction played a major role. By 1903, the Minneapolis Steel & Machinery Company had a plant along Hiawatha Avenue between East 28th and Lake Streets which covered about two and one-half blocks. The largest building was the structural (riveting) shop, about 250 by 125 feet in dimension. Other major buildings housed the machinery shop, foundry, blacksmith shop, pattern (template) shop, pattern storage, and other large storage areas. A 1908 source states the company had 1,200 employees. Among the products it advertised in 1909 were steel structural buildings, store fronts, stairs, water tanks and towers, bridges, and steel grain elevators. Like Gillette-Herzog, Minneapolis Steel and Machinery served a large regional market. The third firm in the Twin Cities was the St. Paul Foundry Company, which apparently did bridge fabrication only, not contracting. From its plant at Como Avenue and Mackubin Street, it also produced mill buildings, tanks and towers, and ornamental iron.[79]

It is possible that these fabricators prepared much of the steel for Minnesota bridge contractors who did construction only. Among these were Minneapolis-based builders such as M. A. Adams, A. Y. Bayne, and the several Hewett firms, as well as companies in such smaller cities as Red Wing and New Ulm, which bid on and won bridge contracts. The Minneapolis Steel and Machinery Company prepared the steel for bridges ranging in size from a 63-foot, riveted Warren pony truss [No. 12] built in 1908 in Goodhue County by Red Wing businessman William P. Glardon to the 622-foot steel deck arch Soldiers Home Bridge [No. 5756] erected over Minnehaha Creek in Minneapolis by Bayne & Hewett. Minneapolis Steel and Machinery apparently also played an important role in establishing high standards for steel bridges built in Minnesota just prior to the establishment of the Minnesota State Highway Commission, which created its own standards. In the early 20th century, many local governments, because they were trying to save money for construction costs, hired contractors to erect bridges of low quality. In the absence of state government specifications, Minneapolis Steel and Machinery promulgated a set of standard bridge specifications to local governments, developed especially for Minnesota traffic conditions (heavy steam traction engines placed the greatest stresses on Minnesota bridges at that time).[80]

Patterns of Bridge Builders' Business

In researching the builders of bridges in the various areas of Minnesota, certain patterns seem to appear. For example, A.Y. Bayne apparently obtained an especially large number of the bridge contracts in Fillmore and Rice counties in the early 20th century and M.A. Adams usually was successful bidder in Lac Qui Parle and Redwood counties during that period.[81] This pattern may be due to a practice of "pooling," which was common in Minnesota and elsewhere during the late 19th century and perhaps the early 20th. H.E. Horton is known to have participated in pooling arrangements prior to his moving to Chicago. He and such companies as the King Iron Bridge and Manufacturing Company, the Wrought Iron Bridge Company, S.M. Hewett, and the Gillette-Herzog Manufacturing Company staked out territories. Whenever a bridge construction project was advertised, agents for each of the companies would meet near the site and discuss the cost of the project. If they could agree, they would permit the company in whose territory the bridge would be built to submit the low bid, allowing for a comfortable profit, and the others would submit higher bids. If they could not agree, then the bidding would be truly competitive. At the conclusion of the project, the successful bidder would disperse a portion of the profits to the other companies in the pool. This helped companies obtain revenue during lean years when there might not be much construction activity in their respective territories.[82] Although no known evidence indicates that the major Minneapolis-based bridge builders participated in such pooling arrangements, they had worked with one another at various stages of their careers and the geographical patterns suggest that such pools may well have existed.

The major Minneapolis-based bridge builders were apparently the most successful of the Minnesota contractors. Nevertheless, they certainly did not, as a group, build every bridge in the state during the various periods of their activity. Contractors from states to the south and east continued to bid on projects and were often successful in obtaining contracts. In the northwest part of the state, the Fargo Bridge and Iron Company of Fargo, North Dakota, was active (its only known surviving bridge is the 1907 Kragnes Bridge, No. 90818, over the Buffalo River in Clay County).[83] Moreover, contractors who do not appear to have made a career of bridge building occasionally were successful bidding on projects. For example, the Mayer Brothers of Mankato were the successful bidder on the 1904 Ziegler's Ford Bridge [No. L-5659] over the Big Cobb River in Blue Earth County.[84] The Mayer Brothers were an iron and steel fabricating firm who, as far back as the 1890s, manufactured earth-moving machinery, boilers, jails, and architectural iron work. They did not advertise themselves as bridge contractors or fabricators and are not know to have bid on other jobs.[85] In another instance, H. Hauser was the successful bidder on the Swede's Forest Bridge [No. 89851] over the Minnesota River between Redwood and Renville counties.[86] He owned the Hauser Lumber Company in nearby Fairfax. Like many lumbermen, he probably also engaged in a fair amount of contracting and likely had contact with a fabricator of steel bridges. He bid on several other projects in the area as well, but this is the only bridge he is known to have built.

THE ERA OF STATE CONTROL OF BRIDGE BUILDING

Around the turn of the 20th century, despite the fact that many high quality bridges were erected, reformers pointed out that often local governments awarded contracts to the lowest bidder in the absence of sound technical advice. As a result, shoddy structures had been built and the state was plagued with collapsing bridges. Most bridge accidents in Minnesota were in the nature of steam traction engines overloading small wooden bridges, a problem due in part to the transition from animal power to the mechanized era. Bridge experts noted, however, that a significant number

of bridges failed due to faulty design, poor workmanship, and inadequate construction supervision. Furthermore, most local governments did not have the resources to hire trained and experienced bridge engineers. Elected officials often relied on the advice of travelling agents of the competing bridge building firms, many of whom were quite skilled at sounding technically informed, but actually lacked the engineering training or experience necessary to specify a bridge for a given location. Sometimes the county surveyor had training and experience in bridge design and construction, but there was no guarantee that the county commissioners would act on his advice.[87] As the <u>Second Annual Report of the State Highway Commission of Minnesota</u> editorialized in 1908: "A great defect in Minnesota's highway system is that bridges are contracted for without advice or assistance of a bridge engineer, and there is no supervision of construction. Reputable companies build only the best, but if a county insists on light and cheap, they can find someone to build it."[88]

The Minnesota legislature moved to correct the situation in stages. In 1905, the legislature created the Minnesota State Highway Commission (SHC), called for the appointment of a State Engineer, and appropriated $5,000 for the salary of the engineer and other costs of the commission. The SHC hired George Cooley (Andrew Rinker's former partner) as its first engineer. As an incentive to local governments, the legislature offered state aid for bridges which met specifications established by the State Engineer. To do so, the local government could either submit its own plans or ask the State Engineer for assistance. Meeting state standards usually resulted in a higher cost bridge, but local governments which participated in the program did not complain, and, in fact, advocated that the MHC offer expanded services.[89]

An example of the way this early process worked can be seen in the history of construction of the Bullard Creed Bridge [No. 12]. The Goodhue County commissioners requested bids for a small bridge in Hay Creek Township. Seven bridge builders responded in January, 1908, each with its own plans (and one, the Security Bridge Company, with three plans), some of which were for concrete and some of which were for a steel bridge. In May, Louis Wolff of Loweth and Wolff met with the commissioners to explain to them the advantages of building a bridge designed to meet state specifications. The commissioners agreed to pay Wolff a fee of $100 for such a design and the project was re-bid. In June, 1908, seven contractors, different from the earlier group, submitted bids for bridges meeting state standards which were somewhat higher in cost, and the contract was awarded to William P. Glardon, who owned a draying business and a wood and coal dealership in Red Wing.[90]

Based on early demand for assistance from the State Highway Commission, the legislature increased the annual appropriation to $8,700 in 1909. Convinced of the benefit of expert supervision of bridge construction, the 1911 legislature amended original State Highway Commission law to require that assistants to the State Engineer must supervise all state-aided bridge construction. The commission was given an annual budget of $150,000 and employment was increased to 45 staff engineers. In 1913, the law was again amended to specify that the SHC must participate in projects which cost over $500. Local governments were supposed to submit plans and specifications for such bridges to the SHC for inspection, or the local governments could request that the SHC provide such documents for a proposed bridge. SHC engineers would also inspect the bridge during the course of construction and at completion. During 1912, for example, the Bridge Department of the SHC furnished plans for 214 steel and concrete bridges, provided miscellaneous assistance for a total of 410 bridges, and completed final inspections of 148 bridges. By the end of 1913, the SHC had prepared 84 sets of standard plans for bridges ranging in span from 10 to 190 feet.[91]

Thus, 1911, marked the end of the era of bridge builders supplying bridge designs. Although each local government still had the option of hiring its own bridge engineer, either in a full time staff position or as a consultant for a construction project with special conditions, design for bridges exceeding $500 in cost had to meet SHC specifications and be inspected by SHC engineers. Although some local governments, especially the larger ones, hired their own engineers, most counties and towns looked increasingly to the SHC for guidance. Consequently, after 1911 bridges in Minnesota assumed much greater similarity, lacking the subtle differences in portal bracing or means of connecting floor beams to superstructure which characterized the bridges of the various builders in the previous era, especially the 19th century.

EPILOG

The adoption of standardized plans coincided with the rise of reinforced concrete as a major structural material. Standardized plans reduced the variety of metal truss designs. Increased use of reinforced concrete reduced the frequency with which metal truss were built. As bridge engineers became more familiar with the new material, they increasingly specified reinforced- concrete slab-and-girder construction for crossing that otherwise would have been spanned with a pony truss. Designers also came to recognize the advantages of reinforced concrete for longer spans as well, especially in the arch configuration over deep gorges. Although metal truss bridges continued to play a major in Minnesota during the 1920s and 1930s, they would never regain the dominant position they had enjoyed during the period 1880-1910, when they epitomized safe, economical, and durable highway engineering.

By 1930, reinforced concrete had become the dominant material in Minnesota bridge engineering, although its hegemony over short-span structures was challenged by the emergence of a new type of metal construction. In 1931, the Armco Culvert Manufacturers' Association introduced a galvanized, corrugated-iron product known as "Multi-Plate."[92] Corrugated iron had been used in culverts since 1896. Although highway engineers initially questioned the materials durability, subsequent field inspections generally agreed with a 1924 Minnesota study that "corrugated pure iron pipe is superior in every detail and much more economical than either cast iron pipe or reinforced concrete pipe for small waterways."[93] Despite such glowing accounts, corrugated metal culverts had one distinct drawback: they were shipped in prefabricated sections that were difficult to handle in the field.

This problem was alleviated by Armco Multi Plate, which was manufactured in "circular segments that are assembled in the field by bolting the plates together instead of being shop-fabricated complete."[94] The built-up design permitted the construction of larger spans with thicker gauge, and since the individual segments could be shipped in a "nested" position (something which is impossible for a complete, cylindrical culvert), they were cheaper to transport than prefabricated culvert. Although Multi Plate's chief application was backfilled pipe culverts, Armco also aggressively marketed a low-cost bridge design using Multi-Plate arches for spans up to about 25 feet. To prevent undermining and shifting of the structure, the arch was generally anchored to concrete abutments with concrete or stone headwalls.[95]

When stone was used in the headwalls, the Multi Plate structure took on the appearance of a stone-arch bridge, which strongly appealed to New Deal sensibilities concerning roadside beautification, local craftsmanship, and labor-intensive public works projects. Armco shrewdly emphasized these points in its advertising: "Multi Plate Arches . . . Designed to fit any local conditions -- Can use local labor on Work Relief Projects. Use of stone end-walls not only makes attractive structure, but employs local material and labor."[96] In Minnesota, approximately 35 Multi Plate "stone-arch" bridges survive from the New Deal period. The following are especially picturesque in their design: the two-arch bridge over Milliken Creek in Dodge County [No. 89096], the three-arch bridge over Turtle Creek in Todd County [No. L-7075], the two-arch bridge over a tributary of the Zumbro River near Zumbro Falls in Wabasha County [No. 3219], and the two-arch bridge over Mission Creek in Duluth [No. 5757].[97] After World War II, the Multi Plate arch was largely replaced by the Multi Plate arch pipe, a backfilled ovoid structure that requires neither abutments for headwalls.[98]

Since the period during which the bridges described in this context were built, traffic conditions have continued to change, resulting in related changes in standards for bridge construction. This fact, rather than decay or collapse--the leading causes of the disappearance of earlier wooden bridges from the landscape--is the major reason why so few iron and steel truss bridges survive to this day. Automobile and truck traffic is now much more dense and moves at higher speeds, resulting in a need for bridges which are wider than those built in the early 20th century. Consequently, bridges at many locations have been replaced in recent years by structures meeting current standards. Because the increase in traffic density has been greater in and near urban areas, a greater percentage of the surviving steel or iron truss bridges are found in relatively remote locations of rural Minnesota.

NOTES

1. For overviews of Minnesota's railroad history, see Henry A. Castle, Minnesota: Its Story and Biography 3 vol. (Chicago: Lewis Publishing Co., 1915), vol. 1, pp. 434-446; Blegen, Minnesota: A History of the State, pp. 295-304.

2. Ibid.

3. John M. Wickre, "Railroads," in Nicholas Westbrook (ed.), A Guide to the Industrial Archeology of the Twin Cities (St. Paul-Minneapolis: Society for Industrial Archeology, 1983), pp. 72-87; Steven Glischinski, "A Tale of Twin Cities," Trains, Oct. 1986, pp. 24-36.

4. For a map of railroad-platted townsites in one county (Blue Earth), see "The Blue Earth County Multiple Resource Area," (report in the files of the State Historic Preservation Office, Minnesota Historical Society; 1979).

5. Federal Writers' Project, Minnesota: A State Guide (New York: The Viking Press, 1938), pp. 48-63, discusses urban growth in its overview history. The ten largest cities in Minnesota at the turn of the century were, in order, Minneapolis, St. Paul, Duluth, Mankato, Winona, Stillwater, Faribault, Red Wing, Brainerd, and St. Cloud.

6. Scott F. Anfinson, "Archeological Potentials for the West Side of the Central Minneapolis Waterfront" (report for the Minnesota Historical Society, 1984), p. 76.

7. Franklyn Curtis-Wedge (ed.), History of Wabasha County, Minnesota (Winona: H. C. Cooper, Jr., & Co., 1920), pp. 113-114.

8. John R. Stilgoe, Metropolitan Corridor: Railroads and the American Scene (New Haven: Yale University Press, 1983), pp. 167-188, is a discussion of road-railroad crossings.

9. Minneapolis Tribune, 7 March 1888; "G.N.Ry.-C.St.P.M.&O.Ry. Joint Report, Short Line Bridges, July 2, 1931" [Great Northern Collection, Minn. Hist. Soc.: V.P.-Operating, box 21 F 14 6F], pp. 64-65, 196-197.

10. Arthur J. Larsen, The Development of the Minnesota Road System (St. Paul: Minnesota Historical Society, 1966), pp. 305-306.

11. Robert M. Frame III, "Historic Bridge Project," (unpublished report to the Minnesota State Historic Preservation Office, 1985), pp. 8-9.

12. Frame, "Historic Bridge Project," p. 9; Daily Minnesotan, May 15, November 23, 1857; Pioneer Democrat, May 11, 1858.

13. F.B. Maltby, "The Mississippi River Bridges: Historical and Descriptive Sketch of the Bridges over the Mississippi River," Journal of the Western Society of Engineers 8(August 1903): 434-436.

14. St. Anthony Express Weekly, July 5, 1856.

15. Mankato Weekly Record, January 8, 1870.

16. Horton's career in Minnesota is well described in Eli Woodruff Imberman, "The Formative Years of Chicago Bridge & Iron Company" (PhD dissertation, University of Chicago, 1973); for a description of Horton's first bridge, see p. 100.

17. Carl W. Condit, American Building: Materials and Techniques from the Beginnings of the Colonial Settlements to the Present (Chicago: University of Chicago Press, 1968), pp. 96, 100-101; J.A.L. Waddell, The Designing of Ordinary Iron Highway Bridges (New York: John Wiley & Sons, 1891), pp. iii-iv; J.A.L. Waddell, Bridge Engineering (John Wiley & Sons, Inc., 1916), pp. 20-21.

18. Waddell, Bridge Engineering, pp. 17, 28; Charles C. Schneider, "The Evolution of the Practice of American Bridge Building," Transactions of the American Society of Civil Engineers 54 (1905):218, 222.

19. Book of Designs of Wrought Iron Bridges Built by the Wrought Iron Bridge Company of Canton, Ohio (Canton: Hartzell & Saxton, Printers, 1874), pp. 8-9, 20-21; David A. Simmons, "The Risk of Innovation: Ohio Bridge Patents in the 19th Century," Proceedings of the First Historic Bridges Conference, (Columbus: Ohio Historical Society, 1985), pp. 118-119, 123; Waddell, Bridge Engineering p. 17;

20. Minneapolis Daily Tribune, March 5, 1869, January 1, 1871; St. Paul Daily Pioneer, December 29, 1870.

21. Book of Designs of Wrought Iron Bridges, p. 10.

22. St. Paul Daily Press, February 25, 1872; St. Paul Daily Dispatch, November 16, 1874; Minneapolis Tribune, January 1, 1873.

23. "The Blue Earth County Multiple Resource Area," p. 2.

24. Blue Earth County [Mankato], "Commissioners Record," Book A, p. 496.

25. Minneapolis Tribune, February 18, 1873.

26. Thomas Hughes, History of Blue Earth County (Chicago: Middle West Publishing Company, 1908), p. 307.

27. Blue Earth County, "Commissioners Record," Book A, p. 535.

28. This conclusion is based on Frame's "Historic Bridge Project." An earlier masonry arch bridge in Washington County (1872) has lost its integrity of design and materials. The oldest surviving bridge structure, which has lost its integrity of location and setting, is the Zumbrota Covered Bridge. Built in 1869 and recorded by the Historic American Buildings Survey shortly after its establishment in the 1930s, the Zumbrota Covered Bridge was moved to the fairgrounds at Zumbrota in 1932. In 1970, the bridge was again moved. It now sits in a specially-designated park next to the Zumbro River. The bridge does not span the river, however.

29. Blue Earth County, "Commissioners Record," Book A, p. 579.

30. Blue Earth County, "Commissioners Record," Book B, pp. 1, 3, 157, 160, 294, 295, 345.

31. Robert Newbery, "Metal Truss Highway Bridges in Wisconsin," unpublished draft, 1988, n.p., Wisconsin Department of Transportation.

32. This statement is based on research in a fairly small, but geographically dispersed, sample of local government records examined during the course of this project. A definitive, quantitative statement to this effect would only be possible after a thorough analysis of all local government records in the state.

33. Kenneth Broas, "Steel Arch Bridge, HAER No. MN-18," Historic American Engineering Record documentation, National Park Service, Denver, 1987.

34. "Erection of the Wabasha Street Bridge, St. Paul, Minn.," The Engineering News 25(December 26, 1891): 58-59.

35. Curtiss-Wedge, History of Wabasha County, Minnesota, p. 113-114; Imberman, "The Formative Years of Chicago Bridge and Iron Company," p.236.

36. Blue Earth County, "Commissioners Record," Book B, pp. 562, 573.

37. Alan Kramer, "Lake/Marshall Bridge, HAER No. MN-6," Historic American Engineering Record documentation, National Park Service, Denver, 1987.

38. Fredric L. Quivik, "Montana's Minneapolis Bridge Builders," IA: The Journal of the Society for Industrial Archeology, 10(1984): 39.

39. Ibid, pp. 39, 45.

40. Wright County [Buffalo], "Commissioners Record," Book E, p. 95.

41. Wright County, "Commissioners Record," Book E, p. 96.

42. "MNDOT Supplemental Structure Inventory," form in MNDOT file for Br. No. 90980.

43. Quivik, "Minneapolis Bridge Builders," p. 45.

44. The builder of all four bridges is identified by a maker's plate on each bridge.

45. Quivik, "Minneapolis Bridge Builders," p. 46.

46. Frame, "Historic Bridge Project," p. 76; "Supplemental Structure Inventory" for each bridge in the respective MNDOT bridge files.

47. Again, this statement is based on impressions gained from random, but not scientific, samples of local government records (see note 34). Also, based on the limited field survey accomplished during this project, more Bayne and Adams bridges seem to survive than those of any other bridge builder.

48. Quivik, "Minneapolis Bridge Builders," pp. 44, 46.

49. This bridge is virtually identical to several other riveted Warren pony truss bridges which Adams built in Redwood County. Although a specific record of his building this bridge has not been found (the bridge may have been built solely by the township), inspection of the Redwood County Commissioners Record during the period leading up to 1910 reveals that Adams won most bids in the county.

50. Maker's plates on bridges.

51. Maker's plate on bridge. That the pin-connected Pratt through truss was still prefered in Minnesota at this time for 80-140 foot spans can be seen in the "Standard Specifications for Steel and Concrete Highway Bridge," Minnesota State Highway Commission Bulletin No. 9, April 1, 1912, p. 6; Warren trusses are mentioned only as pony trusses for 45-80 foot spans.

52. Quivik, "Minneapolis Bridge Builders," pp. 42, 44, 45.

53. Maker's plate on bridges.

54. Quivik, "Minneapolis Bridge Builders," p. 46.

55. Brown County [New Ulm], "Commissioners Record," Volume H, pp. 99, 147, 168, 169, 171, 187, 210, 311.

56. Maker's plate on bridges.

57. This bridge was built by the Minneapolis Bridge Company after Bayne had died and Oliver Mattison was president; agreement between Industrial Contracting Company and Minneapolis Bridge Company, May 16, 1930; and memorandum from Joseph J. Bright to E.J. Miller, March 24, 1947, in MNDOT file for Br. No. 4588.

58. Quivik, "Minneapolis Bridge Builders," p. 45.

59. Curzon Dobell, "Prestressed Concrete Tanks," paper delivered at the First United States Conference on Prestressed Concrete, MIT, Cambridge, August, 1951; William S. Hewett, "A New Method of Constructing Reinforced-Concrete Water Tanks," <u>Proceedings</u> of the American Concrete Institute, 19(1923): 41-52; Quivik, "Minneapolis Bridge Builders," p. 45.

60. Maker's plates on bridges.

61. Maker's plates on bridges.

62. Quivik, "Minneapolis Bridge Builders," p. 47; Frame, "Historic Bridge Project," p. 81.

63. Redwood County, "Commissioners Record," Book E, pp. 367, 386, 414, and 431.

64. City Directory for Fargo and Moorhead (Fargo: Pettibone Directory Company, 1901, 1905, 1907, and 1909), listings under Dibley, Fargo Bridge and Iron, and Stranahan; maker's plate on bridge.

65. Frame, "Historic Bridge Project," pp. 94-95.

66. Susan Hodapp, "Smith Avenue High Bridge, HAER No. MN-5," Historic American Engineering Record documentation, National Park Service, Denver, 1984, p. 38.

67. Other cantilever bridges over the Mississippi River were at Winona (1894), Dubuque (1887), Clinton (1891), and Muscatine (1890), F.B. Maltby, "The Mississippi River Bridges," pp. 434-437, 448-449, 457-458, 463-464, 470-471.

68. Frame, "Historic Bridge Project," pp. 93-94; Kenneth Broas, "Steel Arch Bridge, HAER No. MN-18," Historic American Engineering Record documentation, National Park Service, Denver, 1987, p. 20.

69. The history of the Hennepin Avenue bridge is thoroughly documented in Broas, "Steel Arch Bridge, HAER No. MN-18."

70. The 19th-century bridges over the Mississippi River in the Twin Cities, both vehicular and railroad, from the Hennepin Avenue bridge downstream, are illustrated in Maltby, "The Mississippi River Bridges," pp. 419-441. The bridges above Hennepin Avenue were through trusses.

71. Broas, "Steel Arch Bridge, HAER No. MN-18," p. 21.

72. The history of the Marshall/Lake bridge is well documented in Alan Kramer, "Lake/Marshall Bridge, HAER No. MN-6," Historic American Engineering Record documentation, National Park Service, Denver, 1987.

73. Frame, "Historic Bridge Project," pp. 85, 102; Imberman, "The Formative Years of Chicago Bridge & Iron Company," p. 267; Franklin Curtiss-Wedge, ed., History of Dakota and Goodhue Counties, Minnesota (Chicago: H.C. Cooper, Jr., & Co., 1910), p. 590; Maltby, "Mississippi River Bridges," p. 446.

74. Victor S. Clark, History of Manufactures in the United States, Volume III: 1893-1928 (Carnegie Institution of Washington, 1929; reprinted: New York: Peter Smith, 1949), pp. 15-135, contains extensive coverage of the iron and steel industry at the time most of the bridges in this project were built. Mention of the steel mills in Minnesota and at Superior is on p. 45. F. H. Kindl, "The Manufacture of Structural Steel in the United States," Cassier's Magazine 17 (Feb. 1900):259-278, describes the reducing and rolling processes.

75. Charles Evan Fowler, "Some American Bridge Shop Methods," Cassier's Magazine 17 (January 1900):200-215.

76. The Improvement Bulletin, 2 Jan. 1909, p. 3; 6 Feb. 1909, p. 2.

77. Tenth Biennial Report of the Bureau of Labor of the State of Minnesota, 1905-1906 (Minneapolis: Harrison & Smith Co., 1907), pp. 492, 494, 496, 498.

78. Seventh Biennial Report of the Bureau of Labor of the State of Minnesota, 1899-1900 (St. Paul: Pioneer Press Company, 1901), p. 823.

79. Atlas of Minneapolis, Hennepin County, Minnesota, 1903 (Minneapolis: Minneapolis Real Estate Board, 1903), p. 44; Horace B. Hudson, A Half Century of Minneapolis (Minneapolis: Hudson Publishing Co., 1908); The Improvement Bulletin, 2 Jan. 1909, p.3.

80. Minneapolis Steel and Machinery Co., "General Specifications for Steel Highway Bridges," 1908, Minnesota Historical Society Pamphlet Collection; C.E. Nagel, "Highway Bridges," Proceedings of the Minnesota Surveyors' and Engineers' Society, Nineteenth Annual Meeting, 1914, published by the Society, p. 23.

81. To be able to make a definitive statement, one would have to research and record every bridge contract letting in the state, a task far beyond the scope of this project. The conclusions about Bayne and Adams, Rice and Redwood counties, are derived from scanning several years of commissioners minutes for Redwood County, supervisors minutes for Walcott Township in Rice County, and city council minutes for the City of Faribault.

82. Imberman provides an extensive discussion of pooling in his dissertation, "The Formative Years of Chicago Bridge and Iron Company." See especially pp. 153-164, 173-176, 260-262, 267-269, 288. For a list of those bridge builders with whom Horton had pooling arrangements, see the appendix on pp. 603-605.

83. Maker's plate on bridge.

84. Blue Earth County, "Commissioner Record," Book F, pp. 461, 465, 471, 477, 479.

85. The Mayer Brothers had an illustrated advertisement in every issue of the 1895 Improvement Bulletin.

86. Redwood County [Redwood Falls], "Commissioners Record," Book F, pp. 37, 131, 194, 239.

87. Second Annual Report of the State Highway Commission of Minnesota, December 15, 1906 (St. Paul: Pioneer Press, Manufacturing Dept., Printers, 1906), p. 61; Waddell, The Designing of Ordinary Iron Highway Bridges, pp. 158-158; C.E. Nagel, "Highway Bridges," Proceedings of the Minnesota Surveyors' and Engineers' Society, Nineteenth Annual Meeting (St. Paul: by the Society, 1914), p 23.

88. Second Annual Report of the State Highway Commission of Minnesota, p. 62.

89. Report of the State Highway Commission for 1909 & 1910 (St. Paul: Pioneer Press, 1910), p. 21; Report of the State Highway Commission of Minnesota, 1909-1910-1911 (St. Paul: Pioneer Press, 1911), p. 37; Frame, "Historic Bridge Project," p. 71; Meeker County Commissioners to State Highway Commission, resolution dated March 13, 1908, Minnesota Highway Department, Meeker County folder, 1906-1912, Minnesota State Archives, Minnesota Historical Society.

90. Goodhue County [Red Wing], "Commissioners Record," Vol. 7, pp. 564-565, 593-594, 601-602; Curtiss-Wedge, History of Dakota and Goodhue Counties, p. 1017.

91. Report of the State Highway Commission of Minnesota, 1909-1910-1911, p.37; Report of the State Highway Commission of Minnesota for 1912-1913, pp. 9-10; Report of the State Highway Commission of Minnesota for 1914, p. 11.

92. "Corrugated-Iron Pipe of Multi-Plate Design Introduced on Illinois Central Railroad," Engineering News-Record, 107 (November 19, 1931): 805-806; Armco Drainage and Metal Products, Inc., Handbook of Drainage and Construction Products (Chicago: Lakeside Press, R.R. Donnelley and Sons Company, 1955), p. 69.

93. Henry B. Kenny, "State Highway Culverts Inspected," Minnesota Techno-Log, 5 (December 1924): 10. By 1926, corrugated metal had become the preferred material for culverts throughout the country. Only a decade earlier, however, the Minnesota Highway Commission had banned the use of corrugated-metal culverts on state-aid construction projects on the grounds that "they are not permanent" -- "concrete is permanent and is therefore recommended"; see "Materials Used for Highway Culverts," Public Works, 57 (September 1926): 288; Report of the State Highway Commission of Minnesota for 1914 (n. pub., 1915), p. 17; State Highway Commission of Minnesota, "Standard Specifications for corrugated Metal Culverts," Bulletin No. 14 (n. pub., 1915), p. 1.

94. "Corrugated-Iron Pipe of Multi-Plate Design Introduced on Illinois Central Railroad," 805.

95. Handbook of Culvert and Drainage Practice (Chicago: Lakeside Press, R.R. Donnelley and Sons Company, 1937), p. 260-265; "Details of a Beautiful Stone Arch Bridge," Public Works, 66 (September 1935), 13; Beautiful Low-Cost Bridges (Minneapolis: Lyle Culvert

and Pipe Company, 1935).

96. Advertisement for "Armco Multi Plate Arches, Lyle Culvert and Pipe Company," in Minnesota Federation of Architecture and Engineering Societies, 23 (May 1938). In 1935, the Roosevelt Administration required that at least one percent of federal highway allotments to the states be expended on "Roadside Development Projects;" ensuing government publications prominently featured Multi Plate "stone-arch" bridges as examples of highway beautification. See " Highways . . . and Where They Lead You in Marvelous Minnesota" (Minnesota State Highway Department, 1937), n.p.; Works Progress Administration of Minnesota, WPA Accomplishments (no pub., 1939), n.p.; Biennial Report of the Commissioner of Highways of Minnesota for 1935-1936 (Minneapolis: Syndicated Printing Co., 1937), p. 28; Biennial Report of the Commissioner of Highways of Minnesota for 1937-1938 (Minneapolis: Syndicated Printing Co., 1939), p. 18; Harold E. Olson, "Roadside Development Along the Trunk Highways of Minnesota," Minnesota, 23 (April 1938): 10-11.

97. This brief assessment of surviving Multi Plate bridges is based primarily on a review of MNDOT inventory files for all structures computer-identified as Multi Plate; see "DOT Bridge Inventory Listing of Steel Arch Structures with Main Span Less that 75'," unpublished computer printout, February 1987, MNDOT.

98. Armco Drainage Products Association, "Low-Clearance Drainage Structures, The Armco Pipe-Arch" (no pub., 1941); Jeffrey A. Hess, Interview with Clement P. Kachelmyer, Preliminary Design Engineer, MNDOT, May 12, 1988.

ASSOCIATED PROPERTY TYPES

I. **Name of Property Type:** Iron and Steel Frame Bridges

II. **Description**

Iron and steel bridges within this property type each consist of a framework superstructure which supports the roadway over the span of the bridge. The framework consists of individual members which form a prominent geometric pattern of solids and voids. Each individual member consists of iron or steel shapes of various sizes, such as angle sections, channel sections, I-beams, and round and square rods. Some composite or built-up members consist of multiple shapes attached to each other by means rivets and lacing bars, lattice bars, or batten plates. Historically, wrought iron was the preferred material for these members prior 1890. There was a brief transitional period in the early 1890s, following which steel was the almost exclusive material of choice for bridge designers and builders. Despite the metallurgical difference between wrought iron and steel, bridge fabricators used the two materials similarly in producing various members. Furthermore, in most instances the framework configurations for bridge superstructures built of iron members and superstructures built of steel members were virtually identical.

There are other kinds of iron and steel bridges in Minnesota which differ from those included in this property type. Multi Plate Arch Bridges, which are discussed as a separate property type (see continuation sheet F.10), are built of galvanized, corrugated, plates which are bolted together on-site to form a vault similar to a culvert. The Multi Plate Arch supports earthen fill which in turn supports the roadway. Multi Plate Arch Bridges therefore do not constitute a framework. Likewise, steel stringer and steel girder bridges do not constitute a frame, but rather rely on simple I-beams (steel stringers) or built-up girders to carry the roadway between the supports. Although their use is associated with important historical changes in industrial capacity to produce such shapes and in contractors' ability to economically erect bridges using such shapes (due to changes in the relative costs of transportation, energy, labor, and materials), steel beams and girders do not, by themselves, represent the important engineering and associated historical developments which iron and steel truss and arch bridges represent. Consequently, they were not surveyed during this project, nor are they described in this "Multiple Property Documentation Form" as a property type.

The Minnesota Department of Transportation (MNDOT) divides bridges in this property type into four categories, which characterize their differing framework configurations They are: iron and steel pony (low) truss bridges, iron and steel through (high) truss bridges, iron and steel deck truss bridges, and iron and steel arch bridges. This MNDOT categorization follows accepted engineering nomenclature for bridges. The choice of one of these four types of bridges was usually determined by site conditions. Pony or through truss bridges were generally selected when there was relatively little difference between the level of the road and the level of the water, whereas deck truss and arch bridges were used where that elevation difference was great, such as when a bridge was needed to carry a road over a deep gorge. Pony trusses served relatively short spans, through and deck trusses served long spans, and arch bridges served very long spans.

An iron or steel arch bridge differs from any of the truss bridge types because arches, rather than trusses, span between supports. An arch bridge consists of iron or steel rib arches (built-up members) carrying an iron or steel frame which transfers the load from the deck to the arch ribs.

Bridges in the first three categories (pony, through, and deck) are distinguished by the position of the roadway, or deck, relative to the pairs of trusses which span between supports (piers or abutments). In the case of a pony truss bridge, the deck is attached to the lower chord, or bottom edge, of each truss and the trusses are low enough that there is no need for overhead bracing to resist lateral sway. For a through truss bridge, the deck is also attached to the lower chords, but the trusses are high enough that they require overhead bracing to resist lateral sway. The deck is attached to the upper chord, or top edge, of each truss in the case of a deck truss bridge.

Bridges in this property type may also be categorized by the configuration of the trusses themselves. In most cases, the name for each truss type comes from the person or company who developed it (three of which, the Howe, Pratt, and Warren, have already been mentioned in the historical context). No Howe trusses were found during the survey. Howe trusses dated from the 19th century and usually used wood for the compression members. Minnesota's Howe truss bridges have long since been replaced by other bridges, often iron or steel bridges of this property type.

The Pratt trusses are characterized by vertical compression members (because they are designed to be in compression, these members are relatively thick and prominent visually) and diagonal tension members (because they need only function in tension, these members are relatively thin). Pratt trusses have horizontal upper chords. There are several other truss types related to the Pratt by the fact that they have vertical compression members and diagonal tension members. They include the Parker truss, characterized by a polygonal upper chord; the Camelback truss, having exactly five sides to the polygonal upper chord (including the inclined end posts); the Baltimore truss, having a horizontal upper chord, as well as sub-divided panels; the Pennsylvania truss, having a polygonal upper chord and sub-divided panels; and the "bedstead" truss, so named because it has vertical end posts, resembling a bedstead, rather than inclined end posts. Pratt trusses, and those closely related to Pratt trusses, were used throughout the time period described in the historical context.

The other major type of truss is the Warren, characterized by diagonal members which function in both tension and compression and therefore are relatively thick. The diagonal members form a "W" pattern along the length of the truss. Warren trusses may or may not have vertical members, which are usually somewhat thinner than the diagonals. Warrens are usually associated with 20th century bridge construction when they began to supplant the Pratt. Although sub-divided and multiple intersection Warrens exist, none of the variations of the basic Warren truss were identified in the Minnesota survey (with the exception of two latticed, pony spans of a bridge in Minneapolis [No. 4016] which were originally built for a railroad). One bridge [No. L-7744] in Lac Qui Parle County was surveyed which does not exactly match either the Pratt or the Warren configurations.

There is another important distinction to make between various truss bridges, and that is the type of connection used at the points where members intersect. During the 19th century, most iron and steel truss bridges were pin-connected, meaning that at each intersection of vertical, diagonal, and chord members, they were held together by a pin set through holes in the members. Around the turn of the century, bridge designers and builders began to make greater use of riveted connections, especially for short-span bridges. This meant that at their intersections, the vertical, diagonal, and chord members were riveted to a steel gusset plate rather than being pin-connected. By the 1920s, the riveted connection replaced pins for many longer spans as well.

In 1911, the Minnesota State Highway Commission (SHC) established specifications which all public bridges costing more than $500 had to meet. These specifications formally began to evolve after the legislature created the SHC in 1905, but not until 1911 did the State try to apply them to virtually all bridges. Prior to the SHC developing its standards, there was a standard practice followed by most reputable bridge builders in Minnesota, yet there were some minor differences in the bridges various builders erected. Trusses of the same type (for example, the pin-connected Pratt through truss) exhibited subtle differences in certain details, such as nameplate patterns, portal bracing, composition of built-up struts and chord members, and floor beam connections. Other than the name plates, which are obvious because of their verbal nature, it is not possible to draw a direct correlation between these various characteristics and the different builders or fabricators in the absence of a comprehensive statewide survey. Nevertheless, these differences do represent the absence of State regulation of bridge construction.

After 1911, bridges in this property type tended to exhibit the standardized characteristics which resulted from enforcement of the State Highway Commission's specifications. For example, floor beam hangers were not allowed (floor beams had to be riveted to the superstructure), and the upper chords of pony trusses had to be a boxed section rather than a simpler configuration, such as paired angle sections. Further standardization resulted from actual designs created by SHC engineers for local governments to use for many typical site conditions. Obvious exceptions to the standardized characteristics were the larger bridges which had to be designed to meet the exigencies of their particular sites. Designs for these bridges, however, had to be inspected and approved by SHC engineers.

Although the superstructure is the most significant aspect of bridges in this property type, the substructure is also important. The earliest bridges in this property type were built with stone abutments and stone piers. Later in the 19th century, the most common substructure consisted of paired, concrete-filled caissons (tubes or cylinders consisting of riveted iron or steel plate). These served as piers under the main span(s) and were typically accompanied by short, timber stringer approach spans. Abutments in these cases might be stone, timber pile with plank back walls, or steel pile with sheet steel backwalls. In the early 20th century, concrete became the preferred--and after 1911, the required--material for abutments and piers, although many bridges from the first decade of the 20th century were still built with the 19th century techniques. Some bridges from the 19th and early 20th centuries retain their historic substructure, while others now have concrete abutments and piers. In a few instances, substructures of county or township bridges have recently been replaced with timber piling in a manner which clearly would not have met the 1911 specifications.

Bridges in this property type are most commonly found in the Twin Cities and in the rural areas of counties south of an east-west line which runs through the Twin Cities. This is the region of the state which experienced the earliest and most intensive rural settlement.

III. Significance

The governing historical context for this property type examines Minnesota iron and steel highway bridges for the period between 1873 and 1945. Since the context applies to some structures that are not yet 50 years old, it is necessary to consider the issue of "exceptional significance." The topic is discussed more for the sake of completeness than relevance. According to the research and field survey findings of this study, there is no indication that any bridge falls into the unusual category. It is therefore recommended that all bridges be evaluated under the normal National Register Criteria A, B, and C. Since research and field survey were conducted on a statewide level, there is a sound basis for making judgments of statewide significance, as well as local significance.

Because virtually every bridge in Minnesota is associated with the "broad pattern" of transportation, one could use Criterion A liberally to find every bridge in the state eligible to the National Register. This, however, would make the process meaningless. Rather, to be eligible under Criterion A, a bridge must have contributed in a meaningful way to the settlement and development of a geographically definable area, facilitated major passage to or through a region, or been significantly integral to the development of an effective transportation system. Consequently large bridges over major rivers are most likely to have significance for their historical associations to regional development or settlement. Smaller bridges may be historically significant for association with the development of an effective transportation system. Examples would include bridges which were built as a result of an important railroad/street grade separation program.

In evaluating a bridge's significance under Criterion A, it is helpful to consult other historical contexts dealing with the general geographical area, especially those prepared for municipal and county surveys. Generally speaking, a bridge is significant for its historical associations with a region, only if it dates from the period of significance established for that region. For example, the second bridge over a major waterway may not be significant for its historical associations if the region's major period of development occurred prior to construction of the bridge.

Bridges are rarely eligible under Criterion B. When a bridge is associated with a significant individual, it is almost always in relation to an engineer, architect, contractor, or fabricator. According to the National Register's guidelines, such cases are to be treated under Criterion C. It is conceivable, however, that a bridge might have played a pivotal role in the career of an important politician or other civic leader who, perhaps, advocated its construction or preservation. In such a case, the structure might be eligible under Criterion B.

Criterion C is most frequently invoked for finding historic bridges eligible for the National Register. As in the case of Criterion A, an overly liberal application might lead to the determination that all bridges are eligible, particularly as "representatives of a type." Rather, Criterion C should be employed to winnow a group of similar resources to a meaningful list. Instead of looking simply to typicality as an indicator of significance, evaluation under this criterion should identify additional important qualities, such as being the sole surviving example, the oldest example, the longest span, the most intact example, the work of a major engineer, fabricator, or contractor, or exhibiting notable engineering or decorative details. By selecting the superlative examples from the major structural categories, a list of truly important bridges can be gleaned from a large number of similar resources.

The bridges in this property type are built of either iron or steel. While it requires a metallurgical analysis to ascertain conclusively whether a bridge is iron or steel (or is comprised of both iron and steel members), date of construction can be a fairly reliable guide. Both cast and wrought iron had been used for bridge construction around the middle of the 19th century, but the failure of the Ashtabula Bridge (Ohio) in 1876 confirmed engineers' suspicions that the brittle nature of cast iron made it unreliable for bridges, even when used for compression members. Wrought iron was well-suited for applications in both compression and tension, and became the standard material for most bridge trusses in the 1870s and 1880s. Even though the Eads Bridge in St. Louis was successfully built of steel in 1874, engineers were reluctant to move to the new material because they were still unfamiliar with its properties and questioned how reliably it could be manufactured. By 1890, however, bridge engineers had allayed their doubts and began using steel for bridges extensively, and by 1894 used steel almost exclusively. In Minnesota, surviving truss bridges which pre-date 1890 may safely be assumed to be of iron and are significant in light of their small number. Bridges built during the transitional period, 1890-1894, may be either iron or steel. Bridges constructed after 1894 are most likely steel. Truss bridges built between the advent of steel as the typical truss bridge material and 1900 are significant as the earliest examples of steel truss bridges in Minnesota.

There are several truss types represented in Minnesota's inventory of surviving historic bridges. The most common among 19th- and early-20th-century bridges is the Pratt truss (usually pin-connected); this type is therefore important to Minnesota because of its early ubiquity. Representatives of this type may be selected for other associations such as length, age, material of construction, or association with important engineer, fabricator, or contractor. Another common truss type from the early 20th century is the Warren (usually riveted); significant representatives may again be identified through other associations. Some types of historic iron and steel bridge are quite rare, and yet are quite important in the evolution of bridge engineering. Examples include the bowstring arch truss, which was an truss type commonly used by early bridge fabricators until the Pratt proved to be superior; the iron or steel arch, which had important applications over long spans, especially in association with deep ravines; and the cantilever truss, which proved useful for especially long spans. Other truss types, such as that resembling a Thacher truss [No. L-7744] in Lac Qui Parle County, are significant examples of the continuing efforts on the part of engineers to devise new configurations which would make truss bridge construction more safe, economical, or durable.

Some truss bridges may be significant because they embody characteristics not typical of standard applications. These may include special decorative features or elements of engineering design which allowed the bridge to meet unusual site conditions. Most truss bridges were unadorned, other than some minor elaboration of the portal bracing or a maker's plate or nameplate listing local government officials. In a small number of cases, however, clients were willing pay a little extra for non-functional decoration, such as finials at the tops of the inclined end posts, elaborately cut-out knee braces for the portal or sway bracing, or cresting along the tops of the portal bracing. Other bridges demonstrate a significant degree of engineering to meet site conditions, such as extreme skew, unusual approach restrictions, or vertical clearance requirements over navigable waters.

While the superstructure of a truss bridge is usually its most significant feature, the approaches and substructure may also be significant as examples of an earlier workmanship and use of materials or of an obsolete engineering or construction practice. For example, reinforced concrete has nearly always been used for the piers and abutments of truss bridges since the 1910s. Prior to that time, however, a variety of other materials and techniques were used. Many 19th-century truss bridges were built on stone abutments until means of using iron and steel were devised. The most common substructure to utilize iron and steel consisted of concrete-filled, cylindrical caissons fabricated out of riveted iron or steel plate. Typically, each end of a truss span would be supported by a pier consisting of a pair of these caissons. Short approach spans would link the main span(s) to the stone or timber abutments. Another turn-of-the-century technique employed steel I-beam piles for piers and abutments. Steel plates or timber planks formed by backwalls of the abutments. These techniques were not allowed under Minnesota State Highway Commission specifications and so disappeared after the first decade of the 20th century.

Several engineers, fabricators, and contractors are important to the history of Minnesota bridge building; therefore, bridges associated with them have historical significance. The Wrought Iron Bridge Company of Canton, Ohio; the King Iron Bridge and Manufacturing Company of Cleveland, Ohio; the Keystone Bridge Company of Pittsburgh, Pennsylvania; the Morse Bridge Company of Youngstown, Ohio; Soulerin, James and Company (later the Milwaukee Bridge and Iron Works) of Milwaukee, Wisconsin; and the Lassig Bridge and Iron Works of Chicago, Illinois, were out-of-state fabricators important for introducing iron bridge technologies to Minnesota. In many cases, these companies were also the contractors for erecting bridges in the state. Horace E. Horton of Rochester and Commodore P. Jones and Seth M. Hewett of Minneapolis were important early Minnesota-based bridge contractors. Soon, several other Minnesota bridge contractors established successful businesses. The most active and important late-19th- and early-20th-century bridge builders were headquartered in Minneapolis and included William S. Hewett, Alexander Y. Bayne, Milo A. Adams, Lawrence H. Johnson, the Security Bridge Company, and the Great Northern Bridge Company. Several of these bridge builders obtained fabricated steel from out-of-state sources, but by the 1890s, several bridge fabricators were well established in Minnesota. The three largest and most important Minnesota-based bridge fabricators were the Gillette-Herzog Manufacturing Company and the Minneapolis Steel and Machinery Company, both of Minneapolis, and the St. Paul Foundry Company.

Several engineers played important roles in the design of Minnesota's truss bridges. Among the earliest was Joseph S. Sewell, who designed the Marshall Avenue/Lake Street Bridge linking St. Paul and Minneapolis. Important early city engineers of truss bridges include Leonard W. Rundlett in St. Paul and Andrew Rinker in Minneapolis. In the first few decades of the 20th century, engineers in private practice, such as William S. Hewett, Charles F. Loweth, Louis P. Wolff, and C.A.P. Turner made important contributions to bridge design. George Cooley is significant as the first State Engineer for the Minnesota State Highway Commission. Early or large bridges associated with significant fabricators, contractors, or engineers, or bridges which clearly demonstrate their professional skills, are very likely historically significant bridges.

IV. Registration Requirements

For a bridge in this property type to be eligible for the National Register, the superstructure itself must be in substantially original condition, including the connections and the composition and configuration of individual composite members. Because the superstructure is the most important feature of bridges in this property type, neither an original substructure nor an original deck and guardrail system are necessary for the bridge to be eligible (although these original components may add to the significance of the bridge). On the other hand, for a bridge in this property type to be eligible, replacement substructure or deck components must be of such scale and composition that they do not overwhelm or otherwise detract from a clear visual impression of the iron or steel frame of the superstructure and its function. Bridges which are eligible under Criterion A or B must have integrity of location. Bridges eligible under Criterion C may have been re-located, but they should retain integrity of setting, i.e. they should still span a channel or body of water, railroad tracks, or some other barrier to vehicular travel.

Iron or steel frame bridges in Minnesota may be eligible for the National Register under Criterion A for their association with events that have made a significant contribution to the broad patterns of American history, Minnesota history, or local history, especially in relation to transportation or regional settlement or development.

A bridge in this property type may be eligible for the National Register under Criterion B for its association with an important individual, if that individual was not the designer or builder of the bridge.

Most eligible bridges in this property type will fall under Criterion C. They may be eligible for their association with important bridge engineers, structural metal fabricators, bridge contractors, or other individuals or firms who made significant contributions to the design and construction of bridges or transportation systems. Bridges of this type may also be eligible because they embody distinctive characteristics of bridge engineering and construction or significant phases in the evolution of bridge engineering and construction. Under Criterion C, a bridge may be eligible if it was or is:

1. Built Prior to 1890. Such bridges are almost certainly built of wrought iron and are very rare.

2. Built During the 1890s. Such bridges are probably steel and represent the first extensive use of this material for bridge construction in Minnesota. They are quite rare.

3. Built Between 1905 and 1911 and can be shown to have been built under the new State Highway Commission Programs. Such bridges represent the first efforts of state government to improve the quality of bridge construction.

in Minnesota and they represent the first phases in the development of standardized bridge specifications.

4. Built by an Important Bridge Fabricator. Prior to the establishment of businesses in Minnesota which fabricated iron and steel bridges, several nationally-significant, out-of-state companies, including the Wrought Iron Bridge Company of Canton, Ohio, the King Bridge Company of Cleveland, Ohio, and the Keystone Bridge Company of Pittsburgh, Pennsylvania, and others supplied bridge materials for Minnesota projects. Eventually, three Minnesota firms achieved statewide importance: the Gillette-Herzog Manufacturing Company, the St. Paul Foundry Company, and the Minneapolis Steel and Machinery Company. Other fabricators, such as the Mayer Brothers of Mankato, may have local importance.

5. Built by an Important Minnesota Bridge Builder. This survey has identified several individuals (and their companies) who were very important to the construction of bridges in Minnesota. They are: Horace E. Horton, Commodore P. Jones (Minneapolis Bridge Company in the 1890s, Minneapolis Bridge and Iron Company, Great Northern Bridge Company), Seth M. Hewett (Hewett Bridge Company, Great Northern Bridge Company), William S. Hewett (Security Bridge Company), Alexander Y. Bayne (Minneapolis Bridge Company after 1914), Milo A. Adams, and Lawrence H. Johnson (Hennepin Bridge Company). Other builders, such as the Fargo Bridge and Iron Company, may be shown to have local importance.

6. Designed by an Important Engineer. This survey has identified several engineers who were very important to the design of bridges in Minnesota. They are: Joseph S. Sewell, Leonard W. Rundlett, Andrew Rinker, William S. Hewett, Charles F. Loweth, Louis P. Wolff, C.A.P.Turner, and George Cooley. Other engineers may be shown to have local importance.

7. A Pony Truss Bridge Which Is not a Pratt or Warren Truss. Such bridges are very rare and represent an important design experiment or design solution to an unusual problem.

8. A Through Truss Bridge Which Is not a Pratt or (after 1911) Warren Truss. Such bridges are very rare and represent an important design experiment or design solution to an unusual problem.

9. A Deck Truss Bridge. Such bridges are very rare and represent a design solution to an unusual site condition.

10. An Iron or Steel Arch Bridge. Such bridges are very rare and represent a design solution to an unusual site condition.

11. A Bridge With Exceptional Ornamentation. Such bridges are very rare.

12. A Bridge Which Exhibits Exceptional Engineering Skill to Meet Unusual Site Conditions. Such bridges represent the work of a master.

ASSOCIATED PROPERTY TYPES

I. Name of Property Type: Multi Plate Arch Bridge

II. Description

Introduced by the Armco Culvert Manufacturer's Association in 1931, Multi Plate is a galvanized, corrugated-iron product that is fabricated in curved segments so that individual pieces can be bolted together in the field to form any part of a complete circle. Multi Plate replaced prefabricated, riveted, corrugated-metal pipe culvert, in use since 1896. Multi Plate's modular nature facilitated field-handling, while permitting the construction of larger spans with thicker gauge. Since individual segments could be shipped in a "nested" position, Multi Plate also was cheaper to transport than riveted culvert.

When a Multi-Plate arch is used in bridge construction, it generally is anchored to concrete abutments with concrete or stone wingwalls at each end. When stone is used for the spandrel walls, the structure takes on the appearance of a stone-arch bridge. Most Minnesota Multi-Plate bridges are of the "stone-arch" type. Constructed almost entirely during the period from 1933 to 1942, they reflect the New Deal agenda of promoting highway beautification, local craft skills, and labor-intensive public works projects. After World War II, the Multi Plate arch was largely replaced by the Multi Plate pipe arch, a backfilled ovoid structure that requires neither abutments nor headwalls.

III. Significance

Compared to the metal truss bridge, the Multi Plate arch bridge enjoyed a very brief period of popularity, confined almost entirely to the decade of the 1930s. During its heyday, however, the Multi Plate arch seems to have provided a viable alternative to reinforced-concrete slab-and-girder construction for short-span bridges. The simpler modular design of Multi-Plate construction made it an ideal choice for the unskilled, work-relief projects of the New Deal era. At the same time, Multi Plate bridge design, by easily assimilating stone headwalls and spandrels, satisfied New Deal priorities for roadside beautification and the encouragement of local craft skills. The significance of the Multi Plate arch bridge, therefore, falls under "Category C." It represents a unique engineering type that frequently incorporated notable aesthetic qualities of local masonry design and workmanship.

IV. Registration Requirements

Since the Multi Plat arch bridge is most notable for its modular corrugated-metal construction and stone headwalls and spandrels, these features should be clearly visible and relatively unaltered. And since the Multi Plat arch bridge enjoyed its vogue at least partly because of the New Deal's encouragement of roadside beautification, the bridge's workmanship and design should be on the original site, harmonious with the general setting, of high aesthetic quality, and of New Deal vintage.

G. Summary of Identification and Evaluation Methods

Discuss the methods used in developing the multiple property listing.

This multi property nomination for iron and steel bridges in Minnesota constitutes a part of a larger statewide survey of historic bridges in Minnesota completed by the Minnesota Historical Society (MHS) and the Minnesota Department of Transportation (MNDOT) under a cooperative agreement. The first stage of the survey was completed in 1985 when Robert M. Frame, III, then a MHS employee, wrote a report, "Historic Bridge Project," for the two state agencies based on his analysis of MNDOT bridge records. From that analysis, Frame recommended a list of several hundred bridges for more intensive survey and analysis as potentially eligible for the National Register. In 1987, MHS contracted with Jeffrey A. Hess of Minneapolis to conduct this statewide survey. He completed the survey and analysis of masonry-arch and movable bridges and subcontracted the survey of concrete bridges to Frame and of metal bridges to Renewable Technologies, Inc. (RTI) of Butte, Montana.

[X] See continuation sheet

H. Major Bibliographical References

Archival Collections

St. Paul, Minnesota. Minnesota Department of Transportation.
Bridge files.

St. Paul, Minnesota. Minnesota Historical Society Records Center.
Great Northern Railway Collection.
Minnesota Highway Department Collection.
Pamphlet Collection.
Redwood County Collection.

[X] See continuation sheet

Primary location of additional documentation:

- [X] State historic preservation office
- [ ] Other State agency
- [ ] Federal agency
- [ ] Local government
- [ ] University
- [ ] Other

Specify repository: ______

I. Form Prepared By

name/title Fredric L. Quivik, Architectural Historian; and Dale L. Martin, Historian
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Selection of Bridge Sample for Field Survey

RTI selected a sample of bridges based on an analysis of certain classes of bridges listed in Robert Frame's "Historic Bridge Project" (1985). Frame inspected the MNDOT records for 213 iron and steel through truss bridges which pre-date 1946, 126 iron and steel pony truss bridges which pre-date 1911, 10 iron and steel deck truss bridges which pre-date 1946, and 10 iron and steel arch bridges which pre-date 1946, as well as several other classes of bridges (concrete, masonry, and movable) which lie outside the scope of this context, "Historic Iron and Steel Bridges in Minnesota, 1873-1946." From that list of 359 iron and steel bridges, RTI selected those which it would survey in the field.

First, RTI separated all of the pre-1911 bridges from the larger group (1911 being the first year in which all bridges built by local governments had to meet Minnesota Highway Commission specifications). The pre-1911 bridges were then grouped by county. Those counties with several surviving pre-1911 bridges were then plotted on a state map to see what geographical distribution resulted. The counties with sizable numbers of surviving early iron and steel bridges all fell on or to the south of an east-west line of counties even with the Twin Cities. Consequently, RTI added Clay and Otter Tail counties to the northwest and St. Louis County to the northeast to the group to be visited to improve geographical distribution of the sample.

After selecting the counties which merited field survey based on numbers of surviving bridges, the total number of bridges within those counties was still well in excess of one hundred, far too many to be able to survey within the allotted budget. RTI then examined the MNDOT files for bridges still potentially within the sample to identify those of a fairly common type (such as riveted Warren pony trusses or pin-connected Pratt through trusses) of which several examples exist within a given county. In such cases, bridges which are relatively clustered remained in the sample and bridges in more remote parts of the county fell out of the sample. At the same time, RTI added several post-1911 bridges, which are located relatively near pre-1911 bridges, to the sample to give broader chronological representation.

Finally, RTI compared the sample, thus derived, with Frame's list of bridges which are already listed on the National Register, determined eligible to the National Register, or recommended as potentially eligible to the National Register. In a few cases, such bridges were added to the sample, even though they survive in counties with few or no other qualifying bridges. The resultant sample contains all the bridges which, based on MNDOT records, appear to be of some historical or engineering significance, and contains a broad geographical, chronological, and structural representation bridges not necessarily eligible for the National Register.

Field Recording

Field recording of each bridge consisted of completing a survey form and taking photographs. The single-page form included a sketch of an elevation of the truss and detailed notes on elements such as the composition of chord members, struts, bracing, floor system, and substructure. Each bridge was covered in three standard photos: an elevation, a three-quarters view, and through (along the axis of the road). Special features such as builders' plates, unusual chord intersections, floor beam connections, or portal configurations merited extra photos.

Research

Because of the time limits and geographical range of this survey, RTI was not able to research the history of each bridge surveyed. For some, the only historical information obtained was from copies of MNDOT files in the State Historic Preservation Office and builders' plates. In several selected counties and in the Twin Cities, however, RTI attempted more extensive historical research, with the degree of success depending of the nature of government jurisdiction and records during the historic period of this project.

The main governmental sources on bridges built before the state assumed a large role in setting administrative and design standards in 1911 are records of counties, townships, and incorporated cities. The hand-written or typed minutes of county commissioners' meetings often include frequent mention of bridges among discussion of topics such as roads, budget matters, drainage ditches, and school district boundary rulings. In many Minnesota counties--among them, Fillmore, Lac Qui Parle, and Rice--township boards made the decisions concerning the construction and financing of, and contracting for, bridges and the minutes of the county commissioners (who usually provided matching funds and advised township officers) reveal only vague information: the name of the township, feature crossed, and perhaps cost. Other commissioners' records offer detailed information: petitions from residents for new bridges, accounts of discussions and disagreements concerning projects, lists of bidders, and details of construction and completion. In some counties, Blue Earth notable among them, the county government assumed responsibility for many bridge construction projects; in such instances, county records yielded significant historical detail.

Township records were more problematic, primarily because they are stored in the local town hall, a small public building which is only open for elections or infrequent meetings of the town supervisors. The town clerk usually works during the day and thus is not available without prior notice to open the town records to researchers. Nevertheless, arrangements were made to research the records of several townships, including Walcott in Rice County and Chester in Wabasha County. This research pointed out a second problem with township records: they contain minimal information about the actual construction of bridges. Town boards seem to have been more concerned with authorizations for expenditures of funds for bridges than with technical considerations. Neither minimum specifications for bridges nor lists of bidders and their respective bids were found the township records examined.

City governments also built bridges and have records which provide historical data. In the Twin Cities, RTI found published records of city council meetings and engineering drawings and contractual information on microfiche in the two Public Works Departments. In the much smaller cities of Cannon Falls and Faribault, the manuscript records of city council meetings offered useful information.

Additional sources on specific bridges included published histories of cities and counties, government publications and reports (primarily from the State Historic Preservation Office and the Department of Transportation), articles in technical texts and journals, manuscript collections of the Minnesota Highway Commission at the Minnesota Historical Society's Archives and Manuscripts Center, and, for street bridges built by the Great Northern Railway over its tracks, the GN Collection at the Minnesota Historical Society's Archives and Manuscripts Center.

County Government Documents

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Wright County, courthouse in Buffalo

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