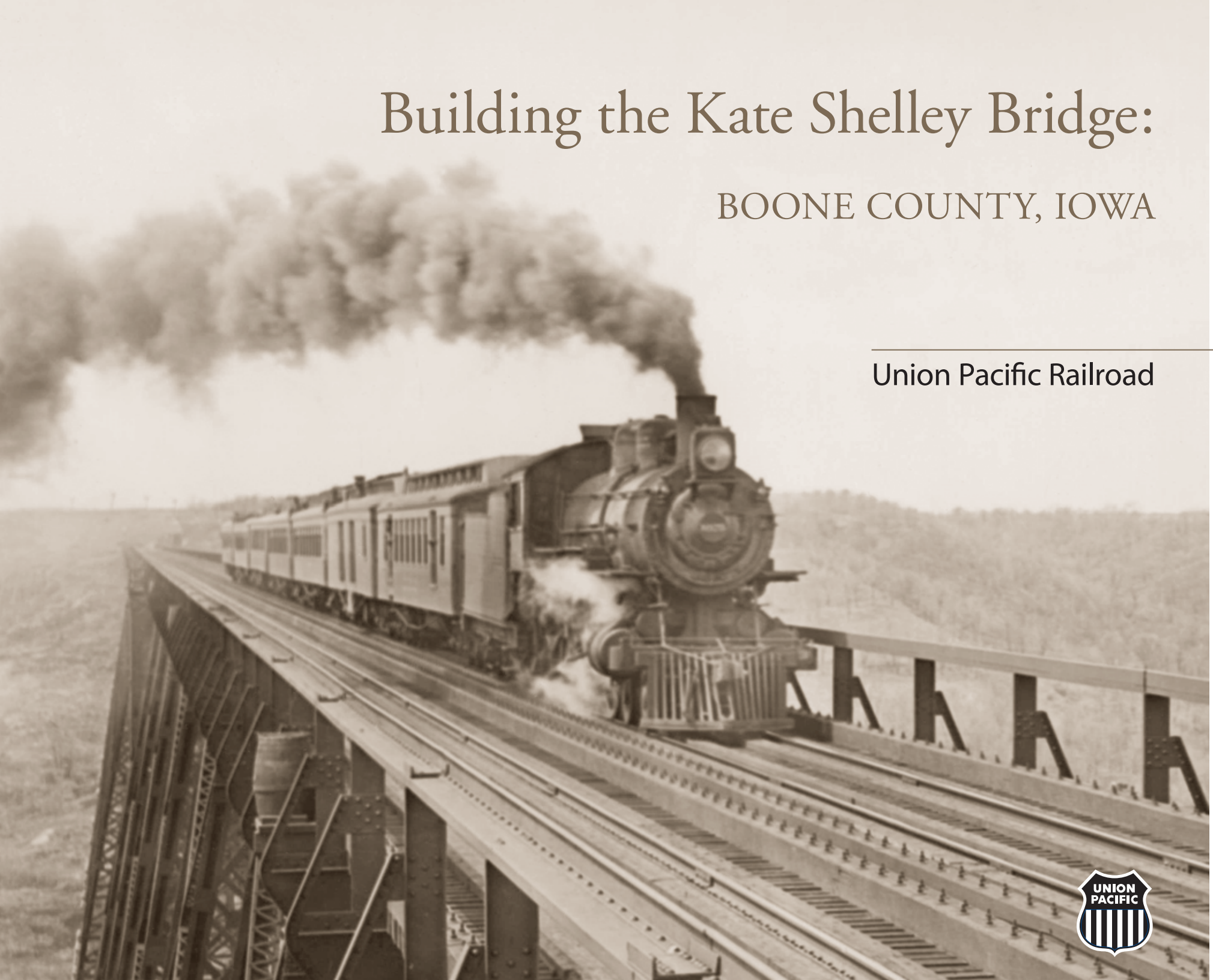
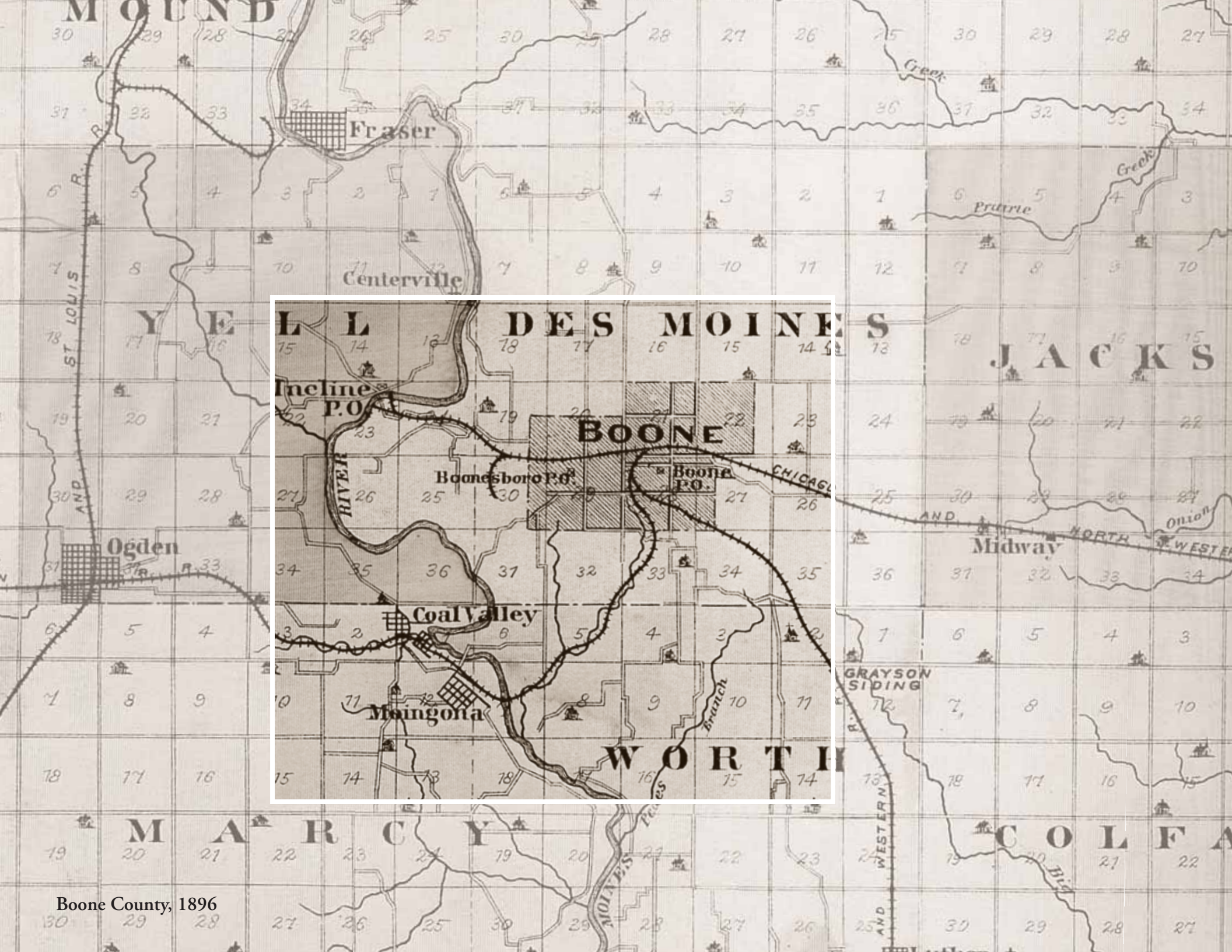
Building the Kate Shelley Bridge:

BOONE COUNTY, IOWA



Union Pacific Railroad



Boone County, 1896

Building the Kate Shelley Bridge:

BOONE COUNTY, IOWA

By Joe Trnka
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HDR, Inc.

For the Union Pacific Railroad

With special thanks to:
Suzanne Caswell and Charles Irwin; Boone County Historical Society
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This booklet was produced under the terms of a Memorandum of Agreement, pursuant to Section 106 of the National Historic Preservation Act, between the U.S. Army Corps of Engineers, the Iowa State Historic Preservation Office, and the Union Pacific Railroad regarding the construction of a new, parallel bridge adjacent to the historic Kate Shelley Bridge (Boone Viaduct).

2009

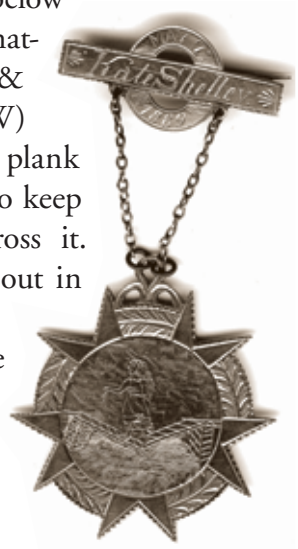
Kate Shelley

Fifteen-year-old Kate Shelley lived in a modest house next to Honey Creek along with her widowed mother and four younger siblings. It had been a wet summer and many of the creeks in the area were already full of water when a large summer thunderstorm lashed the area on July 6, 1881. After her mother and siblings had gone to bed, Kate stayed up to keep an eye on the barn and its animals, which were threatened by the rising water of Honey Creek.

Around 10 p.m. that evening, an engine and crew were sent out of the Moingona Station, west of the Des Moines River and Honey Creek, to test the track and the bridges between Moingona and Boone. The crew did not know that storm debris had already seriously damaged the Honey Creek Bridge. When the engine reached the bridge, it toppled into the swollen water of the creek. A fireman, Amos Pope Olmsted, was killed; his body was never recovered. The engineer was trapped by the raging floodwater.

Kate heard the crash of the nearby accident and the hissing of a steam boiler in the creek over the noise of the storm. Grabbing a lantern and a coat, she ran out to investigate. She quickly found the wreck and saw that there was nothing she could do by herself to rescue the trapped engineer. More importantly, she knew that the *Atlantic Express* was due to arrive in Moingona at 11:27 p.m. Once it departed Moingona, it would soon be crossing the now washed-out bridge.

Kate braved the lightning and thunder of the fierce summer storm to warn the railway personnel at the Moingona Station. To get there, she had to cross the bridge across the Des Moines River in total darkness with the rain-swollen river mere feet below the old bridge. To make matters worse, the Chicago & North Western (C&NW) Railway had removed the plank walkway from the bridge to keep people from walking across it. Kate's lantern had blown out in the storm so she was forced to crawl across the bridge on her hands and knees; her path lit only by the lightning of the summer thunderstorm.



ABOVE
A cabinet portrait of Kate Shelley made by local photographer J.C. Kincade sometime around 1890. She is wearing the medal commissioned for her by the State of Iowa.

LEFT
The medal commissioned for Kate Shelley by the State of Iowa.

Arriving storm-battered and bruised at the Moingona Station, Kate warned them that the Honey Creek Bridge was out. The Atlantic Express was held at the station and its cargo of approximately 300 passengers was saved from a certain accident that could have cost many lives. A rescue crew was dispatched and the engineer was rescued from the wreck in Honey Creek.

Kate's heroism saved many lives and resulted in considerable national publicity. The State of Iowa awarded her a medal that was struck in her honor. Later, in 1890, her family received a new home, courtesy of the *Chicago Tribune*. The *New York Times* reported in a story published on May 19, 1901, that it was the C&NW's intention to name their new steel high bridge for Kate Shelley. *The Railway and Engineering Review* made the same statement on May 25, 1901. In 1903, the C&NW hired Kate to be a railway agent at Moingona Station. Kate Shelley passed away in 1912.

ABOVE
Kate Shelley, the Moingona Station Agent for the Chicago & Northwestern Railway, in 1903. The two-story Moingona depot burned down in 1901. The small building behind her was brought in to serve as a temporary depot.

RIGHT
Kate Shelley in front of her family's modest frame home on Honey Creek, circa 1885.

Construction of the Kate Shelley Bridge

(Formally known in May 1901 as the Boone-Ogden Cut-off)

The construction of the Kate Shelley Bridge at the beginning of the 20th Century was one of the most significant engineering accomplishments of its time. Heralded as the longest, tallest, double-track railroad bridge in the world when it was built, this bridge became an instant icon for Boone County, the State of Iowa, and railroad enthusiasts from around the world. Like many great accomplishments, this crossing of the Des Moines River had a modest beginning.

The Cedar Rapids and Missouri River (CR&MR) Railroad Company was one of four land-grant railroad companies chartered in Iowa in 1856. The CR&MR was chartered to connect Cedar Rapids, which had been linked via rail to Chicago in 1860, with Council Bluffs on the Nebraska-Iowa border. The CR&MR erected their first bridge across the Des Moines River in 1866 and went on to become the first railroad to cross Iowa when it reached Council Bluffs in 1867. Through a series of mergers and acquisitions in the late 1800s, the CR&MR line became the property of the C&NW, which went on to become one of the largest railroads in the United States.

RIGHT
The Big Fill – Much of the work in 1899 involved site preparation, grading, and earthwork. Temporary wooden structures were built to convey thousands of horse-drawn wagons of fill material used to construct the earthen approach embankments at either end of the bridge. Approximately 223,000 cubic yards of fill material were required to construct these embankments, which reduced the total bridge length by about one-sixth. The wooden structures were removed once the embankments were in place.

ABOVE AND TOP
In 1899, horses and humans still provided the vast majority of the non-stationary power at construction sites. Here, workers using horse-drawn teams gather and convey fill material for the earthen embankments constructed at both ends of the bridge.

The original CR&MR line between Boone and Ogden was 11.3 miles long with 5.8 miles on curves. The new route constructed by the C&NW between 1899 and 1901 reduced the distance traveled by approximately 3 miles with only four-tenths of a mile being on curves. The westbound traffic originally faced 4.13 miles of grade with a total ascent of 205 feet; this was reduced to 2.48 miles of grade with a total ascent of 47 feet on the new line. The eastbound traffic originally faced 4.98 miles of grade with a total ascent of 248 feet; this was reduced to 3.92 miles of grade with a total ascent of 90 feet on the new line. The original route required additional engines to help the trains negotiate the grades; the new bridge eliminated this need. When combined with the double tracking of the entire route between Boone and Ogden, the construction of the Kate Shelley Bridge (also known as the High Bridge) significantly reduced the potential for delay in crossing the Des Moines River.

Preliminary site surveys for the new crossing were conducted in 1898 and preliminary design plans were drawn up that same year. Preliminary bridge design was conducted by the Office of the Engineer of Bridges for the C&NW under the supervision of Mr. W.H. Finley. The preliminary design plans were revised by a consulting engineering firm in New York City before the final design plans were provided to the steel fabrication companies. The steel was manufactured by Carnegie in Pittsburgh, Pennsylvania. The steel fabrication work was contracted with the Union Bridge Company of New York and divided among a number of firms in Pittsburgh, Milwaukee, Wisconsin, and Chicago, Illinois. The steel fabrication work was reported at the time to be one of the largest fabrication projects of its kind in the nation.

Construction began in the fall of 1899 under the direction of Mr. W.C. Armstrong of the C&NW. Mr. Armstrong was an Iowa native originally from Marietta. In 1908, he went on to lead the construction of the new double-track, swing span railroad bridge across the Mississippi River at Clinton, Iowa.

The High Bridge and its associated earthwork abutments span a total distance of approximately 3,000 feet. The bridge is 2,685 feet in length and 27 feet wide. At its highest point above the Des Moines River, it is 185 feet high. The river span is a 300-foot subdivided Pratt truss type supported on A-shaped towers. The remainder of the bridge consists of 18 two-bent braced towers, each spanning 45 feet at the top, and 21 intermediate spans of 75 feet carried by plate girders between the towers.

Continued on page 8

TOP
November 1900 – Workmen using a traveling derrick begin to erect the eastern end of the high bridge. The individual pieces of the bridge were formed at the foundry and then riveted together in the field.

BOTTOM LEFT AND RIGHT
By 1900, the construction site had changed dramatically. Once the site was cleared, an incline railway was extended down the eastern bank, cranes were in place to move the heavy stone blocks for the piers, and a temporary bridge crossed the Des Moines River.

Construction Work in 1900

TOP
In a photograph dated May 5, 1901, these workers are taking a break by posing for local photographer A.E. Moxley on the bottom chord of one of the A-shaped bridge span towers.

BOTTOM
The east end of the project site included housing and support buildings that were erected for the construction crew. A number of wooden buildings, including at least 20 one-story frame houses and one two-story frame building, were present. These buildings were removed once the project was complete.

Construction work in 1900 was dramatically different than it is today. Perhaps the most noticeable change is in the job sites themselves. As these construction photos attest, work site safety requirements were minimal when compared to a modern job site. Notice that none of the workers shown in these photos wears a safety harness to protect them from falls. Also, none of the workers are wearing eye protection or hard hats. Finally, while not quite as obvious, some of the workers in these photographs appear to be very young.

In 1900, there was no comprehensive legislation governing workplace safety. There was no prohibition against employing boys as young as 10 years of age in often dangerous work environments. If a worker was injured, his only recourse was to sue his employer for damages. Generally, such lawsuits were unsuccessful. Workplace injuries were routine and deaths were not uncommon.

Workplace safety increased dramatically between 1900 and 2000. While few workplace statistics are available for 1900, two sets of numbers tell of important changes. The Bureau of Labor reports that there were 2,550 railroad workers killed in 1900 compared with 56 killed in 1999. Almost 1,500 coal workers were killed in 1900 compared with 35 in 1999.

In 1900, it was common for large companies to feed and house their workers on-site, and deduct a portion of their pay for room and board. Workplace hours averaged 10 to 12 hours per day and the work week was often 6 days. Having housing on-site eliminated the need for workers to commute, either by horse or on foot, and meals were often provided. Entertainment opportunities were limited, especially in remote work locations.

Workplace compensation also improved dramatically between 1900 and 2000. In 1900, per capita income averaged $4,200 per year or around $1.30 per hour for a 60-hour work week. Many of the workers pictured here likely earned closer to $1.00 per hour or less once fees to cover room and board were deducted. Per capita income averaged $33,700 per year in 1999, or around $16.20 per hour for a 40-hour work week. Highly skilled construction workers often earn substantially more for their effort.

LEFT
May 1901 – With the bridge largely complete, these construction workers pose for local photographer A.E. Moxley on the bottom of the 300-foot truss span. These workers appear very comfortable despite the fact that they are at least 150 feet above the ground with no safety gear — two of them are even rough-housing while this photograph was being taken.

TOP RIGHT
While it appears primitive by today's standards, the construction crews were provided with the best equipment then available. This crew appears to be very proud of their role in one of the biggest, most dramatic construction projects taking place anywhere in the country.

Continued from page 4

Work started with clearing the job site of trees and brush, followed by preliminary earth work. Initial activity included construction of a temporary pile bridge to cross the Des Moines River. The temporary bridge was used to transport material from one side of the river to the other because all of the construction material arrived on the east side of the river. An incline railroad track was laid on the slopes to handle the heavy stone and steel building materials. Earthen embankments with masonry abutments were constructed at both ends of the bridge. Approximately 223,000 cubic yards of earth were required to construct the embankments. The abutments are approximately 85 feet high at their highest point and constructed of reinforced masonry. Temporary wooden scaffolding was erected to build the embankments and was removed once the embankment was finished. Horse-drawn equipment was used to gather and move the fill material. The fill for the earthen embankments was extended around the front of each abutment, so only a portion of each abutment is actually visible.

ABOVE AND RIGHT
Summer of 1900 – The caissons are complete and the temporary bridge has largely been removed. The large size of each caisson is illustrated by two women enjoying the shade cast by one on an Iowa summer day.

ABOVE AND LEFT
By the summer of 1900, the caissons and piers are finished and the site is nearly ready for the erection of the steel superstructure.

The towers supporting the 300-foot river span rest on steel cylinders sunk to a depth of 42 to 46 feet below the surface. The steel cylinders, or caissons, are of five-eighths-inch thick steel plates riveted together in five-foot sections and sunk by the pneumatic process. The pneumatic process required an open-bottom caisson that kept the water out through the use of air pressure. This required workers inside the caissons to excavate the material largely using picks and shovels. Air for the pneumatic work was provided by two 60-horsepower Ingersoll-Sargeant air compressors installed on the river bank. The air pipes were carried to the caissons under the floor of the temporary bridge spanning the river. A Moran air lock was installed on each caisson to provide access

TOP
Building materials being unloaded at the east end of the construction site.

ABOVE
December 1900, erecting the steel on the east end of the bridge.

for workers and for the removal of excavated material. The caissons had a maximum air pressure of about 23 pounds per square inch above atmospheric pressure at their deepest, which was not deep enough to cause workers to suffer from decompression sickness, or "the bends." The workers managed to excavate quickly at first, with the caissons progressing downward as much as 16 feet per day. Work slowed as the harder layers were encountered at deeper levels and progress averaged as little as 2 feet per day. When sunk to a sufficient depth, the caissons were filled with concrete and capped by masonry. Installation of the caissons began on February 7, 1900 and was completed by June 6, 1900.

The caisson piers were completed before the masonry piers. The masonry piers consist largely of rectangular blocks of Mankato limestone masonry laid in Portland cement mortar. The piers are 5 feet square on top with bases ranging from 12 to 20 feet square depending on the height of the pier. The foundations for many of the piers are concrete beds placed at a depth of 12 to 14 feet below ground surface. For the piers near the river, the foundations consist of driven piles cut off at the water level and capped by concrete. The piers are topped by pedestal blocks of Albeman's sandstone.

There are 5,680 tons of metal in the bridge structure and 400 more tons of metal in the foundations, for a total of 6,080 tons of metal. All of the metal, including the rivets, is of soft steel per C&NW specifications. The majority of the rivets are seven-eighths-inch in diameter.

The two-bent columns consist of H-shaped sections formed by two 20-inch I-beams connected by a 15-inch I-beam. The bottom of the tallest tower is a rectangle 70 feet in one direction and 45 feet in the other; all of the towers span 45 feet at their tops. The longitudinal and sway bracing is formed by two 12-inch channels laced together. The bracing is of a Warren girder type with all of the braces running diagonally and intersecting each other in the center. The only horizontal braces are at the bottoms of each tower where the columns are connected by 15-inch channels. Each column is anchored to its respective pier by anchor bolts that are 1.5 inches in diameter. The tops of each column tower are united by plate girders that are 4-feet deep.

The plate girders that connect the two-bent columns rest on top of the girders connecting the tower column tops. Both the 45-foot and 75-foot spans are bridged using plate girders that are 7 feet deep. This size was selected to provide uniform connections that were economical to fabricate and easy to

Continued on page 13

LEFT
A modern construction site in the summer of 1900. The system of cables was used to transfer building materials from rail cars to the smaller carts on the incline railroad. Meanwhile, a stationary steam engine provided power to the site.

RIGHT
Looking west across the construction site in the summer of 1900.

Continued from page 10

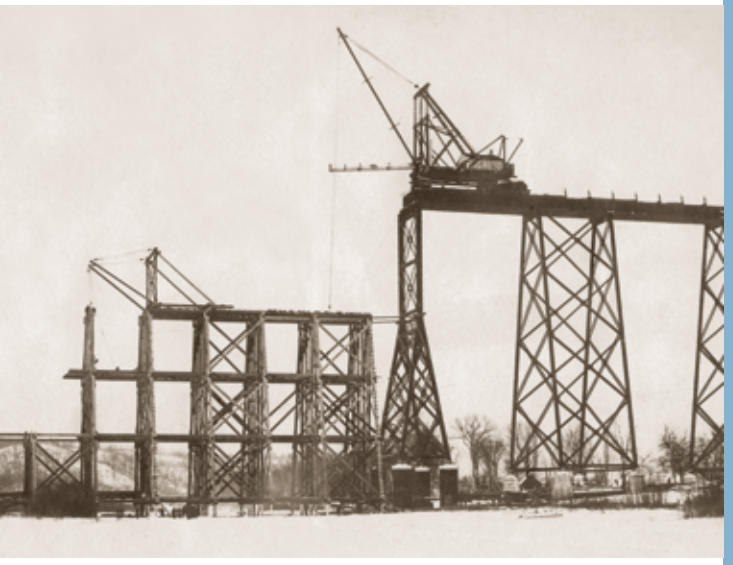
connect. There are four lines of these plate girders, two under each track. The girder webs for the 45-foot spans are seven-sixteenths of an inch thick; half an inch thick for the 75-foot spans.

The 300-foot river span is a deck structure 60 feet deep that is carried by two trusses of five subdivided panels. The posts at one end are arranged as a rocker bent to allow for thermal expansion and contraction. The river span was constructed using temporary wooden falsework—the only portion of the bridge that required the use of falsework during construction. The wooden falsework supported the river span while it was being assembled. Once the bridge was complete, the falsework was disassembled and floated down the Des Moines River so it could be reused on other construction projects.

The bridge was tested before it was opened to general traffic. The testing involved the use of engines pulling several cars that were heavily loaded with sand. An engine was run out onto the bridge at a high rate of speed. Upon receiving a given signal, the engine was reversed, its emergency brakes were engaged, and it was stopped within 60 feet of travel. The tests started with one engine and then progressed to using two engines simultaneously. The bridge passed the tests and was opened for general traffic the following day, May 19, 1901.

At the time of its completion, the Kate Shelley Bridge was reported to be the longest double-track structure of its height and the heaviest metal structure of its class in the world.

ABOVE AND LEFT
The steel was erected using a traveling derrick. The derrick had two booms; a 51-foot-long horizontal boom with a 30-degree traverse and a 90-foot-long diagonal boom with a 75-degree traverse. A steam-powered hoisting engine provided lifting power through the use of block and tackle.



ALL PHOTOS

Erecting the steel took approximately 6 months. Construction progressed through the winter of 1900-1901. Steel erection started on the east and west ends and worked toward the 300-foot center span. Once the eastern A-tower was completed, wooden falsework was built to support the 300-foot center span while it was being assembled. This is the only use of wooden falsework in the entire project. The falsework was disassembled once the project was completed and the wood was floated down the Des Moines River for recovery and reuse elsewhere.

ABOVE AND RIGHT
Two early photographs by local photographer, A.E. Moxley, depicting the newly completed bridge. The photograph to the right is dated 1901 and was taken shortly after bridge completion. The other photograph is dated 1902 and shows the Des Moines River at a high water level.

Guarding the Bridge

In the 20th Century, the Kate Shelley Bridge was an important component of the national rail transportation system. Thus, there have been times when the U.S. Army has posted soldiers at the bridge in order to prevent acts of sabotage. The first time the bridge was known to have been guarded was during World War I. These photos, dated April 1917, were taken in the same month that the United States entered that war. The U.S. Army guarded the bridge again during World War II.

The soldiers appeared to be housed in a tent camp near the High Bridge. Given that America had just entered the war, it is most likely that these soldiers were local troops from a nearby Army National Guard unit. Their equipment, including their bolt-action Model 1903 Springfield rifles, conforms to the Army standards for 1917.

RIGHT
Soldiers of the National Guard camp at the High Bridge in 1917.

ABOVE
The High Bridge in 1917.

RIGHT
The National Guard camp at the High Bridge, 1917.

ABOVE
Floyd Henry Thompson guarding the High Bridge, April 1917, the same month the United States entered into World War I.

RIGHT
Floyd Henry Thompson and another soldier at the High Bridge camp in April 1917.

A New Beginning

As the 20th Century progressed, the very success of the C&NW, and the national railroad system in general, began to threaten the Kate Shelley Bridge. Trains got bigger, heavier, and crossed the bridge more frequently as the century progressed. By the 1950s, the Kate Shelley Bridge had begun to show its age. Crossing speeds were reduced and eventually only one train was allowed to cross at a time. This reduction led to a bottleneck for the C&NW and later, the Union Pacific Railroad (UPRR), which acquired the C&NW in 1995. By the late 1990s, plans began to move forward to replace the Kate Shelley Bridge with a modern structure capable of accommodating existing and projected train traffic. Construction of the $43 million dollar concrete, double-track replacement bridge began in 2007. On August 20, 2009, the first UPRR train crossed over the new concrete bridge, thereby closing one chapter of the story of the Kate Shelley Bridge. No longer in use, the Kate Shelley Bridge remains in place, demonstrating how the railroads have changed since 1901. More importantly, it continues to remind viewers of the heroic action of a 15 year old girl who risked her life on a stormy night in 1881 to save the lives of countless strangers.

LEFT
The first train across the new concrete bridge. The new, double-track concrete bridge entered service on August 20, 2009.

ABOVE
The construction materials and methods differ between the two bridges, which were built over 100 years apart. However, both bridges clearly provide the same results, a level crossing of the Des Moines River Valley.

BOTTOM LEFT
The alignment of the new concrete bridge closely parallels the alignment of the historic bridge. This minimized revisions to the existing mainline railroad.

BOTTOM RIGHT
The historic Kate Shelley Bridge and the new concrete bridge, viewed from the south from the Wagon Wheel Bridge across the Des Moines River.

Sources:

Copies of all source materials can be found on file at the Boone County Historical Society in Boone, Iowa, or are readily available on the Internet.

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DRIVING DIRECTIONS

From Boone: Begin at intersection of U.S. Highway 30 and South Story Street. Follow Highway 30 west to County Highway R18. Turn right on R18 and head north to Old Highway 30. Turn left onto Old Highway 30 and head west to J Avenue, which initially heads west before curving to the north. Make a right turn onto 208th Street and head east to Juneberry Road. Turn left at the T-intersection and follow Juneberry Road into the Des Moines River Valley, where you will see the old Kate Shelley Bridge and its new companion bridge. There are places along Juneberry Road where short-term parking is allowed. There is also a public parking area on the east end of the Wagon Wheel Bridge along the north side of the road. Please remember to obey all posted restrictions on parking.

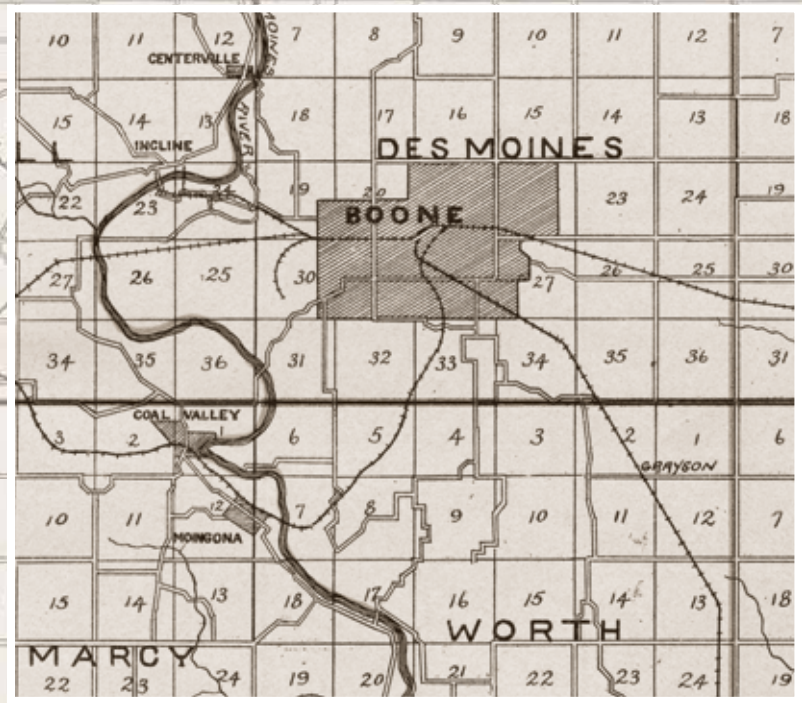
For your own safety, do not trespass onto railroad property. Trespassers face prosecution under both Federal and Iowa State Code.

PHOTOGRAPH CREDITS

All of the photographs and maps, with the exception of those presented on pages 20-22, were graciously provided by the Boone County Historical Society. The photographs on pages 20-22 were provided by the Union Pacific Railroad, HDR, Inc. and Keith Philpott.

OUTLINE MAP OF BOONE COUNTY.

SCALE — ONE INCH, ONE-THIRD MILE



Boone County, 1902

Built by the Chicago & North Western Railway at the beginning of the 20th Century, the Kate Shelley Bridge in Boone County, Iowa remains one of the highest, longest, double-track railroad bridges in the world today. Named for the famous Boone County resident who risked her own life to save a passenger train in 1881, the Kate Shelley Bridge has become known around the world as an engineering marvel. Told within these pages are the stories of both the person and the bridge—two of Boone County's most famous residents.

Union Pacific Railroad